Environmental Resources Document

NASA-Ames Research Center

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Chapter 1. Introduction

1.1. OVERVIEW

The purposes of this Environmental Resources Document (ERD) are to

- Describe the existing environmental setting at the National Aeronautics & Space Administration (NASA) Ames Research Center (ARC)
- Document the effects of the facility and its current operation on the physical, biological, and social environment
- Document a baseline of conditions against which new and proposed actions can be compared and assessed as part of the decision-making process

The ERD is a baseline document; it does not propose new programs or project actions. As a baseline environmental report, an ERD facilitates the preparation of future environmental assessments and/or environmental impact statements (EISs) that are required by NEPA for proposed major federal actions.

1.2. REGULATORY REQUIREMENTS

NASA Procedural Requirement (NPR) 8580.1, "Implementing the Provisions of the National Environmental Policy Act (NEPA)," and 14 Code of Federal Regulations (CFR) 1216.319 require preparation of an ERD. NASA's guidelines suggest that the ERD be updated as needed and thoroughly reviewed and revised every 5 years. This ERD is a revision of the draft 1998 ERD. The draft 1998 ERD reflected an expanded scope over the preceding 1992 document, and included ARC operations at both the Ames Campus and Bayview Area, and those occurring at the site formerly known as Naval Air Station Moffett Field (NASMF), which is described further in Section 1.4.3.

This updated ERD also incorporates information from the NASA Ames Development Plan Final Programmatic Environmental Impact Statement, which was finalized in July 2002 (Design, Community & Environment 2002). This EIS evaluated five alternatives under a proposed NASA Ames Development Plan (NADP) for ARC. The NADP replaces NASA's Comprehensive Use Plan (CUP), approved in 1994, as the operative planning document for ARC.

1.3. REGIONAL SETTING

ARC is located in northern Santa Clara County, at the south end of San Francisco Bay (Figure 1-1). The City of San Francisco is 65 kilometers (40 miles) to the northwest, and the City of San Jose is 16 kilometers (10 miles) to the southeast (Figure 1-2). The Cities of

Mountain View and Sunnyvale are adjacent to the ARC site, Mountain View to the west and Sunnyvale to the east. The U.S. Fish and Wildlife Service (USFWS) administers salt ponds and marshes located to the north; the ponds were previously owned by Cargill Salt Company and used for salt production. These ponds and marshes border San Francisco Bay.

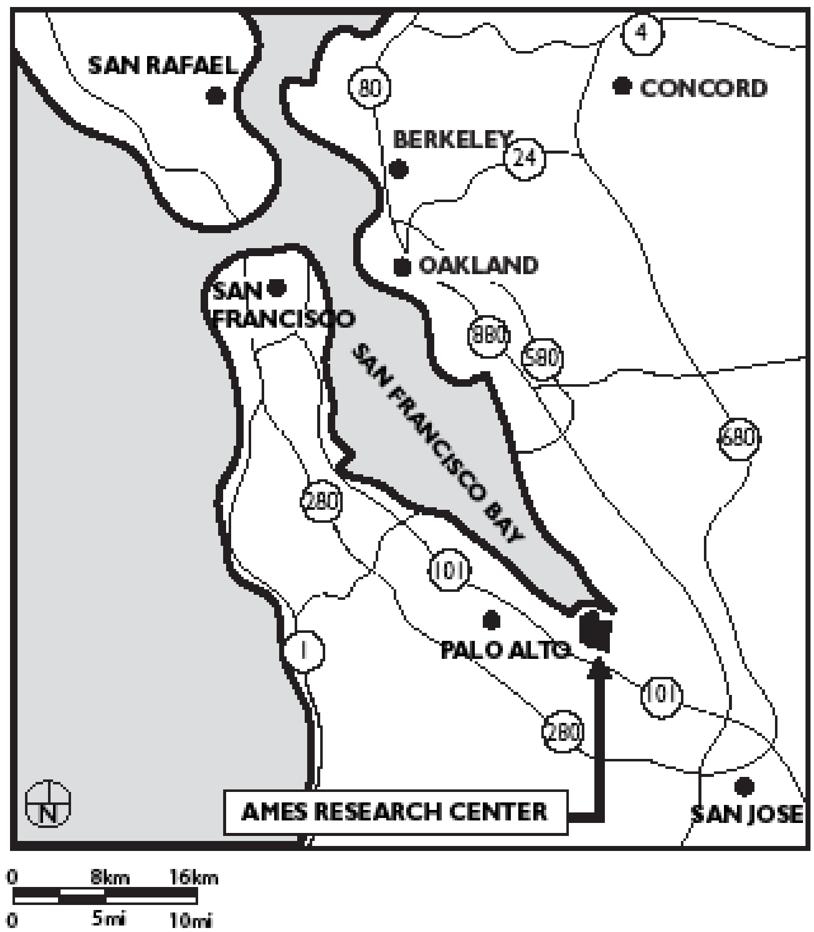

Figure 1-1 Regional Context Map

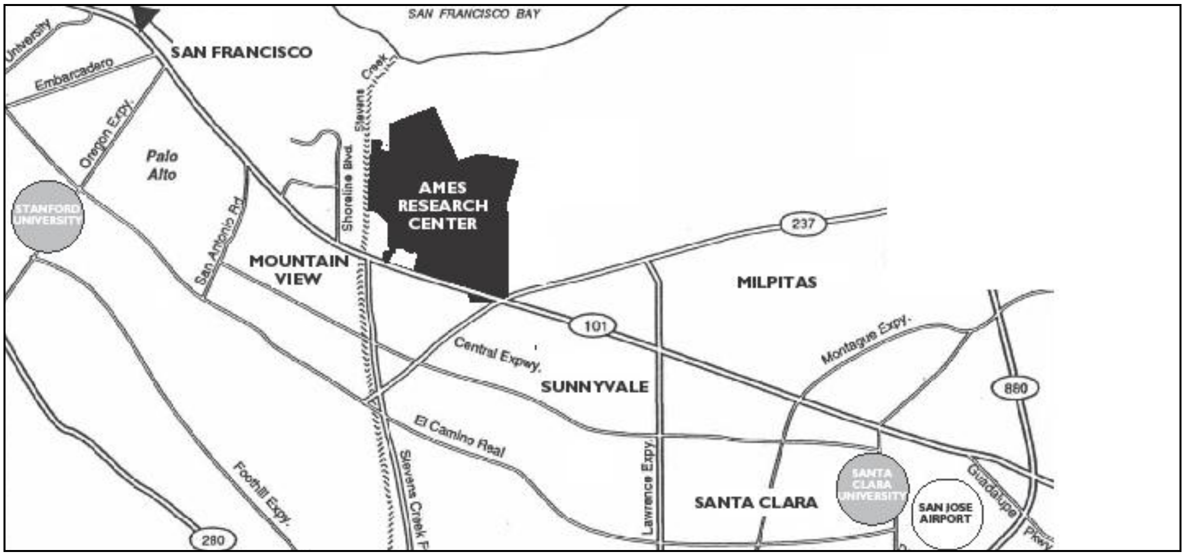

Figure 1-2 Local Context Map

The Bay Area region is a wellspring of one of the most highly educated populations in the country, featuring such institutions as Stanford University, the University of California at Berkeley, University of San Francisco, San Francisco State University, Santa Clara University, San Jose State University, and numerous other colleges, universities, and training institutions.

ARC is in the portion of the San Francisco Bay Area known as Silicon Valley because of its long history as a center of high-technology research, development, and manufacturing. Silicon Valley comprises the roughly triangular area that extends from Mountain View, south to San Jose, and east to Milpitas and southern Fremont. Largely agricultural in the years prior to World War II, this area emerged as a world leader in high technology in the years after the war (City of Mountain View 2001), experiencing rapid urbanization, and economic growth as a result. Following an economic downturn in 2001–2004, the area is now recovering. Despite a shift toward global distribution of high-technology manufacturing, Silicon Valley is expected to remain an important center of technology research and production in the foreseeable future, with computing, consumer electronics applications, defense electronics and avionics, nanotechnology, and biotechnology representing key profit sectors (Silicon Valley Manufacturing Group 2005).

1.4. HISTORY OF NASA AMES RESEARCH CENTER

1.4.1. NASA AMES RESEARCH CENTER

Congress initially established the ARC on August 9, 1939, as the Ames Aeronautical Laboratory, an element of the National Advisory Committee for Aeronautics (NACA). The Ames Aeronautical Laboratory's initial purpose was to conduct research and develop technology for use by military aircraft manufacturers. Upon the creation of NASA in 1958, NACA and all its laboratories were merged into this new agency. The Ames Aeronautical Laboratory was renamed Ames Research Center and was designated as a NASA field center.

ARC's extensive experience in fluid mechanics and aerodynamics became an integral part in supporting NASA's missions (see Chapter 2, "Existing Facilities, Operations, and Their Impacts," for information about ARC's missions). Today ARC continues in this role, and its responsibilities have expanded into the fields of aeronautics, reentry physics, space science, space research, technology development, astrobiology, life sciences, human factors (as applied to both aeronautical and space issues), earth sciences, and information systems (computer technology). Many current programs at ARC are directed toward research and development of nano materials, biotechnology, and information technology in support of NASA's exploration mission. This research also benefits society by addressing problems ranging from human disease and environmental pollution to agricultural pests and global climate change.

1.4.2. NAVAL AIR STATION MOFFETT FIELD

In 1930, in one of the first cooperative regional economic development campaigns, Santa Clara, San Mateo, San Francisco, and Alameda Counties set up a joint program to find a site for a new Navy base, purchase it, and donate it to the Navy. The counties eventually purchased approximately 400 hectares (1,000 acres) at a cost of almost $500,000 and offered it to the Navy for $1. The counties' goal was to establish a west coast Naval Air Station (NAS). On December 12, 1930, this goal was realized when President Herbert Hoover signed the bill allowing the Navy to accept the site and appropriating $5 million for construction. The base officially opened in 1933. On April 12, 1933, the base was commissioned as NAS Sunnyvale. In 1942, the station was named "Moffett Field" in honor of Rear Admiral William A. Moffett.

During its history, the station has served as a home base for dirigibles, the west coast headquarters for coastal patrol blimps, the west coast's largest Naval air transport base, the home base for the Navy's Pacific fighter planes, and the Pacific headquarters for all P-3 anti-submarine efforts, including training, administration, and operations.

1.4.3. MOFFETT FEDERAL AIRFIELD

In October 1991, Congress and President Bush accepted the recommendations of the Base Closure and Realignment Commission (BRAC) to disestablish Naval Air Station Moffett Field. Because the availability of the airfield has become essential to ARC's mission, the BRAC recommended that the site remain a federal property and that the Department of Defense (DOD) negotiate a transfer of responsibility for the airfield to NASA. This suggestion was well received by the neighboring communities.

Moffett Field was closed as a military base on July 1, 1994, and the property was transferred to ARC. It included 578 hectares (1427 acres) of land, three aircraft hangars, and over 325,150 square meters (3.5 million square feet) of buildings and other facilities. It did not include the family housing areas and several related facilities located near Onizuka Air Station, which were retained by the DOD for administration.

The area formerly known as NAS Moffett Field was known for a time as Moffett Federal Airfield (MFA). The former NAS Moffett Field now includes the two planning areas known as the NASA Research Park and the Eastside/Airfield as well as the portions of the NAS Moffett Field known as Wescoat Housing, Orion Park Housing, and Shenandoah Park Housing, that transferred directly to the Air Force and then to the Army. NAS Moffett Field also included Crows Landing, an auxillary landing strip in Stanislaus County, that Congress has directed NASA to transfer to the County once Navy cleanup is completed. Further, NAS Moffett Field also included several holes in the City of Sunnyvale Golf Course, located to the south across U.S. Highway 101. This land provides a clear zone for the airfield. The term "Moffett Field" continues to apply to the postal zone encompassed by the zip code 94035.

1.5. EXISTING CONDITIONS

For purposes of this document, ARC has been divided into four major planning areas: the 86-hectare (213-acre) NASA Research Park (NRP), the 95-hectare (234-acre) ARC campus, the 385-hectare (952-acre) Eastside/Airfield, and the 38-hectare (95-acre) Bay View area. The remaining 144 hectares (357 acres) of NASA-administered land consists of wetlands areas along the northern boundary of ARC. Figure 1-3 shows the location of these planning areas within ARC.

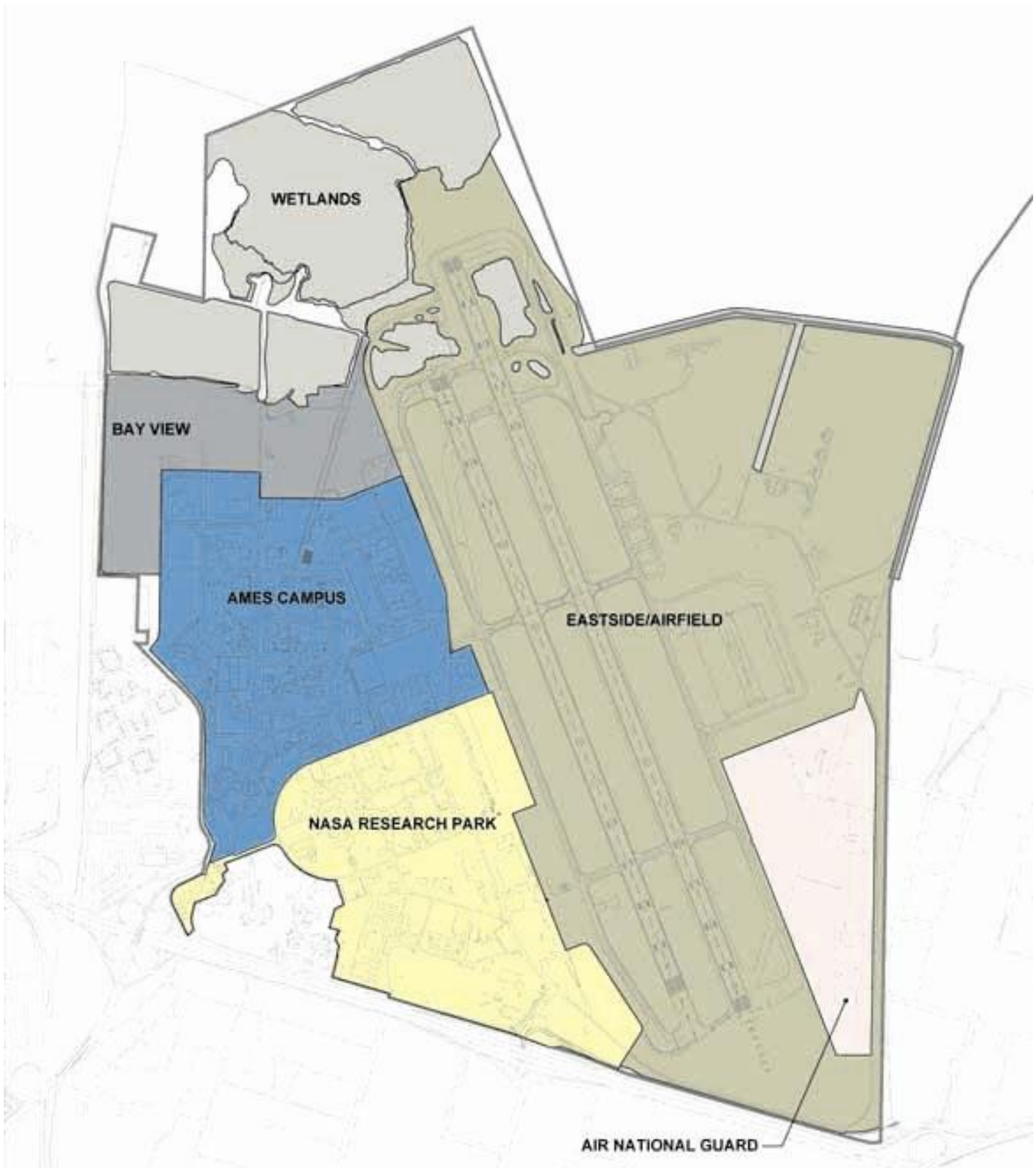

Figure 1-3 Planning Areas

1.5.1. NASA RESEARCH PARK

The NRP is an 86-hectare (213-acre) roughly triangular site located between the airfield, Highway 101, and the original ARC campus (Figure 1-3). This area includes most of the

Shenandoah Plaza National Historic District, except for Berry Court and Hangars 2 and 3. Current uses in the NRP area include office space, educational facilities, retail and business services, airfield operations, vehicle maintenance, research facilities, and storage. Some of these facilities are used by the Army Reserve, Department of Defense Commissary and Exchange, Air Force, and Air National Guard, as well as numerous Space Act Partners engaged in Research and Development related activities. The 140 existing buildings within the NRP area contain approximately 150,000 square meters (1.6 million square feet of space).

1.5.2. EASTSIDE-AIRFIELD

The airfield and the lands to the east of it occupy 385 hectares (952 acres). Current uses of this area include the airfield operations, fueling, and munitions storage facilities of the California Air National Guard; a golf course; and Hangars 2 and 3.

1.5.3. BAY VIEW

The Bay View area is a 38-hectare (95-acre) site immediately north of the original ARC campus. This land is predominantly undeveloped upland grassland supporting a few research facilities such as the Outdoor Aerodynamic Research Facility.

1.5.4. AMES RESEARCH CENTER CAMPUS

The Ames campus is the developed portion of the original 94-hectare (234-acre) ARC site. This area was referred to as "Existing ARC Facilities" in the Notice of Intent for the NASA Ames Development Plan Final Programmatic Environmental Impact Statement filed in June 2000, and in scoping meetings held in July 2000. Current uses in the Ames campus area include offices, research and development, and storage. The existing buildings in the ARC campus area contain approximately 268,000 square meters (2.89 million square feet) of space.

Chapter 2. Existing Facilities, Operations, and Their Impacts

2.1. OVERVIEW

This chapter discusses current missions and goals for NASA and the NASA Ames Research Center (ARC). It also presents an overview of environmental regulatory requirements, as well as an overview of the effects of ARC facilities and operations on the environment. Specific environmental conditions related to facilities and operations are discussed in subsequent chapters in this document. Information regarding NASA's missions provided in Section 2.1.1 below was obtained from the NASA Ames Development Plan Final Programmatic Environmental Impact Statement (Design, Community & Environment 2002), with updated information from the Ames Implementation Plan 2004.

2.1.1. NASA VISION AND MISSION

The NASA Vision is "To pioneer the future in space exploration, scientific discovery, and aeronautic research." In practice, this involves undertaking a wide range of space exploration and aeronautical activities; conducting and supporting research to expand knowledge of the Earth and of phenomena in the atmosphere and space; and reaching out to provide educational opportunities and materials related to NASA activities.

2.1.2. MISSIONS OF NASA AMES RESEARCH CENTER

ARC enables exploration through selected development, innovative technologies, and interdisciplinary scientific discovery. Ames provides leadership in astrobiology; robotic lunar exploration; technologies for the Crew Exploration Vehicle (CEV), the Crew Launch Vehicle (CLV), and the Heavy Lift Vehicle (HLV); the search for habitable planets; supercomputing; intelligent/adaptive systems; advanced thermal protection; and airborne astronomy. Ames develops tools for a safer, more efficient national airspace and unique partnerships benefiting NASA's mission.

2.2. MAJOR ENVIRONMENTAL LAWS, REGULATIONS, AND POLICIES

As a major federal facility, ARC is governed by a variety of laws, regulations, policies, and other guidance. These regulatory directives are enforced by federal, state, regional, and local agencies. Following is a selected list of regulatory directives that are applicable to facility operations.

2.2.1. FEDERAL

- Fish and Wildlife Coordination Act of 1958 (16 U.S.C. §661–666c)
- Wilderness Act of 1964 (16 U.S.C. §1131 *et seq*.)
- Wild and Scenic Rivers Act of 1965 (16 U.S.C. §1271 *et seq*.)
- National Historic Preservation Act of 1966
- National Environmental Policy Act of 1969
- Clean Air Act of 1970
- Marine Mammal Protection, Research, and Sanctuaries Act of 1972 (16 U.S.C. §1361 *et seq*.)
- Coastal Zone Management Act of 1972 (16 U.S.C. §1451 *et seq*.)
- Federal Water Pollution Control Act (Clean Water Act) of 1972, as amended (33 U.S.C. §1251–1376 *et seq*.)
- Migratory Bird Treaty Act of 1972 (16 U.S.C. §703–711)
- Noise Pollution and Abatement Act of 1972 (42 U.S.C. §7641)
- Endangered Species Act of 1973
- Safe Drinking Water Act of 1974
- Archeological and Historic Preservation Act of 1974 (16 U.S.C. §469–469c)
- Toxic Substances Control Act of 1976
- Resource Conservation and Recovery Act of 1976 (42 U.S.C. § 6901-6993 *et seq*.)
- Archaeological Resources Protection Act of 1979
- Fish and Wildlife Conservation Act of 1980
- Farmland Protection Policy Act of 1981 (7 U.S.C. §4201 *et seq*.)
- Comprehensive Environmental Response, Compensation, and Liability Act of 1980
- Emergency Planning and Community Right-To-Know Act of 1986
- Hazardous Waste Source Reduction and Management Review Act of 1989
- Native American Graves Protection and Repatriation Act of 1990 (25 U.S.C. §3001–3013)
- Pollution Prevention Act of 1990
- Oil Pollution Control Act of 1990 (33 U.S.C. §2701 *et seq*.)

- Federal Facilities Compliance Act of 1992
- Presidential Executive Order 11514 (amended by Presidential Executive Order 11991), *Protection and Enhancement of Environmental Quality*
- Presidential Executive Order 11593, Protection and Enhancement of the Cultural Environment
- Presidential Executive Order 11738, Providing for Administration of the CAA and the Federal Water Pollution Control Act with Respect to Federal Contracts, Grants or Loans
- Presidential Executive Order 11988 (amended by Presidential Executive Order 12148), *Floodplain Management*
- Presidential Executive Order 11990, *Protection of Wetland*
- Presidential Executive Order 12088 (amended by Presidential Executive Order 12580), *Federal Compliance with Pollution Control Standards*
- Presidential Executive Order 12114, Effects of Major Federal Actions Abroad
- Presidential Executive Order 12843, Procurement Requirements and Policies for Federal Agencies for Ozone-Depleting Substances
- Presidential Executive Order 12856, Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements
- Presidential Executive Order 12873, Federal Acquisition, Recycling, and Waste Prevention
- Presidential Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations
- Presidential Executive Order 12902, Energy Efficiency and Water Conservation at Federal Facilities
- Presidential Executive Order 13231, Critical Infrastructure Protection in the Information Age
- Presidential Executive Order 13233, Further Implementation of the Presidential Records Act
- Presidential Executive Order 13292, Further Amendment to Executive Order 12958, as Amended, Classified National Security Information
- Presidential Executive Order 13287, Preserve America
- Presidential Executive Order 13423 Strengthening Federal Environmental, Energy, and Transportation Management

2.2.2. California

- California Aboveground Petroleum Storage Act
- California Clean Air Act
- California Endangered Species Act of 1984
- California Fish and Game Code
- California Health and Safety Code
- California Native Plant Protection Act of 1977
- California Oil Pollution Control Act
- California Porter-Cologne Water Quality Control Act
- CCR Title 17, Drinking Water Supplies
- CCR Title 22, Environmental Health
- CCR Title 23, *Waters*
- CCR Title 26, *Toxics*
- Medical Waste Management Act
- State noise guidelines and regulations

2.2.3. Local Regulations and Locally Enforced Codes

- Bay Area Air Quality Management District Rules and Regulations
- Bay Conservation and Development Commission Bay Plan
- San Francisco Bay Basin Water Quality Control Plan (Basin Plan)
- Santa Clara County Hazardous Materials Storage Ordinance
- Santa Clara County Toxic Gas Ordinance
- Santa Clara County Medical Waste Management Plan Guidelines
- Santa Clara Valley Water District Well Standards
- City of Palo Alto Sewer Use Ordinance
- Palo Alto Industrial Wastewater Ordinance
- City of Sunnyvale Industrial Wastewater Ordinance
- Uniform Fire Code
- Uniform Plumbing Code

2.2.4. NASA POLICY PROCEDURAL REQUIREMENTS

- NPD 8500.1A NASA Environmental Management
- NPR 8530.1A Affirmative Procurement Program and Plan for Environmentally Preferable Products June 4, 2009
- NPR 8553.1A NASA Environmental Management System (EMS) w/Change 2 (04/26/2006) March 22, 2010
- NPR 8570.1 Energy Efficiency and Water Conservation w/Change 1 (3/30/04) March 15, 20
- NPD 8910.1A Care and Use of Animals January 8, 2008
- NASA Emergency Preparedness Program Plan
- NASA Floodplain and Wetlands Management
- NASA Policy Directive for Pollution Prevention
- NASA Policy on Use of Chlorofluorocarbon (CFC) and Halon Compounds

2.2.5. NASA AMES RESEARCH CENTER'S PROCEDURAL REQUIREMENTS

- APG 8800.3, Environmental Management Handbook
- APD 8800.4 Ames Environmental Programs

Table 2-1 Environmental Regulatory Agencies Overseeing NASA Ames Research Center Operations

Federal	U.S. Environmental Protection Agency U.S. Army Corps of Engineers U.S. Fish and Wildlife Service U.S. Department of Transportation Advisory Council of Historic Preservation
State of California	Office of Emergency Services California Environmental Protection Agency California Department of Fish and Game Department of Toxic Substances Control
Regional	Bay Area Air Quality Management District Regional Water Quality Control Board, San Francisco Bay Region Bay Conservation and Development Commission
Local	Santa Clara County Health Department Palo Alto Regional Water Quality Control Plans Sunnyvale Wastewater Treatment Plans

2.3. NASA AMES RESEARCH CENTER OPERATIONS

NASA's facilities include the Unitary Plan Wind Tunnels, motion-based flight simulators, atmosphere-entry heat simulators, advanced digital computation systems, and free-flight ballistic test facilities. In addition, there are a wide range of well-equipped ground-based and airborne laboratories that are dedicated to the study of solar and geophysical phenomena, life synthesis, life detection, and life environmental factors. ARC has a number of support buildings as well, including aircraft hangars, machine shops, warehouses, a cafeteria, post office, and numerous office buildings.

As of November 1999, the current replacement value of ARC was estimated to be $3.312 billion, of which the airfield made up $904 million.

A description of each building's specific function follows in the sections below, listed by organizational code. The ARC is divided into directorates, each designated by a letter code. The directorates that make up the ARC are:

D. Office of the Director

A. Office of the Director of Aerospace

C. Office of the Chief Financial Officer

P. Office of the Director of Program and Project Development

J. Office of the Director of Center Operations

T. Office of the Director of Information Sciences and Technology

Q. Office of the Director of Safety, Environmental, and Mission Assurance

S. Office of the Director of Astrobiology and Space Research

T. Exploration

U. U.S. Air Force Liaison Office

W. NASA Office of Inspector General

Y. Aeroflight Dynamics Directorate, U.S. Army Aviation and Missile Command

ZZ. Western Aeronautical Test Range

V. Strategic Communications

For completeness, all of the facilities are listed here, but not all are currently active. Codes C and D are primarily involved in administrative and computer-related functions that do not have environmental impacts. The following sections describe the potential impacts associated with the facilities administered by other directorates.

2.4. FACILITIES IN CODE A: OFFICE OF THE DIRECTOR OF AEROSPACE

2.4.1. SPACE TECHNOLOGY, N-204A

This facility conducts research and development (R&D) on arc jets and thermal protection systems that enable hypervelocity flight in planetary atmospheres. Such R&D was essential for the Apollo, Shuttle, and Galileo Probe vehicles. Advances in thermal protection also support the ongoing exploration of Mars and the outer planets, as well as the development of reusable launch vehicles (for example, the X-33 experimental aircraft). Also under development are aerobraking and advanced regenerative life support technology to permit human exploration of Mars without the need for new, larger launch vehicles.

Other R&D at this facility includes sensor development, particularly in the infrared, and the application of Information Technology (IT) in intelligent systems, integrated design systems, computational fluid dynamics, and nanotechnology for electronics.

2.4.2. FLIGHT SYSTEMS RESEARCH LABORATORY, N-210

The Flight Systems Research Laboratory contains offices and computer laboratories for developing air traffic management automation tools and rotorcraft flight performance analysis software. The computer labs contain high-performance computer workstations in systems furniture to provide an interactive environment for software development and scientific analysis. At the north end of the building there is a high bay that is used for storage. The work conducted in the Flight Systems Research Laboratory is the core of NASA’s contribution to the fields of airspace operations.

2.4.3. ELECTRIC ARC SHOCK TUBE EAST, N-229

The Electric Arc Shock Tube is used for basic science research on flow phenomena at hypervelocity speeds. The electric arc driven shock tube facility consists of one driver system and two parallel-driven tubes. The driver can be operated in a variety of configurations depending on test requirements. The energy to the driver is supplied by a capacitor energy storage system consisting of 220 capacitors. By using different combinations of series-parallel connections, the capacitance of the bank can be varied. This facility contains two large (5,500-horsepower) reciprocating compressors and the auxiliary equipment required to operate the compressors. Included in N-229 is the control room for distribution of high-pressure air across ARC, a mechanic shop, a switchgear room, a welding shop, and a boiler room.

2.4.4. PHYSICAL SCIENCES RESEARCH LABORATORY, N-230

This facility houses the Photophysics, Materials Research, and ISP Sensor Development Laboratories.

The Photophysics Laboratory includes two laser-application laboratories for spectroscopic research and optical instrumentation development, a small supersonic wind tunnel facility for the demonstration of laser diagnostic techniques in high-speed flows, and a large stratosphere-simulation vacuum chamber where laser diagnostic methods were developed for use during space shuttle flight. The lab's high-energy pulsed lasers include ultraviolet excimer gas lasers, multi-wavelength Nd:YAG (neodymium-yttrium, aluminum, and garnet) lasers, and tunable dye lasers.

Research at the Materials Research Laboratory includes an investigation of graphite-epoxy composites and metal matrix composites. The laboratory's hydraulic testing machines are used for mechanical experiments on composite materials used in aeronautic applications.

The ISP Sensor Development Laboratory supports the manufacture of heat flux gauges approximately 0.5 inch in diameter and 0.022 inch thick, used in the Arc Jet Facility, Building 234. To produce the gauges, screen-printed sensors are fired in a furnace to 1550^{o} Celsius to eliminate organics and achieve a solid metal film. The laboratory is used for material inspections and calibration. The calibration process involves repeated temperature steps of up to 1100^{o} Celsius.

2.4.5. HYPERVELOCITY FREE-FLIGHT FACILITY, N-237

The Hypervelocity Free-Flight Facilities (HFFF) provide a unique suite of testing capabilities to study the aerodynamics of hypervelocity flight, atmospheric entry, and the response of materials to hypervelocity impact. The HFFF comprise two ballistic ranges: the Aerodynamic (HFFAF) and the Gun Development (HFFGDF).

The HFFAF is NASA's only Aeroballistic Range and consists of a model launching gun, a sabot separation tank/vacuum chamber, a test section with 16 orthogonal photo stations, a test cabin, and the largest combustion-driven shock tube in the United States. This multifaceted facility can be configured to perform shock tunnel testing, aeroballistic testing, counterflow aeroballistic testing, or hypervelocity impact testing. The 22.9-meter (75-ft) long test section can be filled with various gases to simulate flight in planetary atmospheres. The 40.6-cm (16-in) diameter shock tube is capable of producing high-enthalpy airflow at Mach 7. This flow may be used for fixed-model testing or as a counter-current to the gun-launched models for combined velocities up to 11 km/s (36,000 ft/sec).

The HFFGDF consists of a model launching gun, a sabot separation tank/vacuum chamber, a flight tube, and an impact chamber. This facility is primarily used to expand

and enhance the performance characteristics of the model launching guns used in the HFFF. This range can also be used to perform hypervelocity impact studies to simulate micro-meteoroid and orbital debris impact.

Both ranges were constructed in 1964 and utilize an arsenal of light-gas and powder guns to accelerate particles that range in size from 3.2 to 25.4 mm (0.125 to 1 inch) in diameter to velocities ranging from 0.5 to 8.5 km/s (1,500 to 28,000 ft/s).

2.4.6. FLIGHT AND GUIDANCE SIMULATION LABORATORY, N-243 AND N-243A

The Flight and Guidance Simulation Laboratory, with its 18.3-meter- (60-foot) vertical motion capability, is the world's largest motion-based simulator. The vertical motion simulator (VMS) was designed to provide large-amplitude motion to aid in the study of helicopter and vertical/short take-off and landing (V/STOL) issues specifically relating to research in controls, guidance, displays, automation, and handling qualities of existing or proposed aircraft. The VMS is also used to develop new techniques for flight simulation and to define the requirements and develop the technology for both training and research simulators.

2.4.7. CREW-VEHICLE SYSTEMS RESEARCH FACILITY, N-257

The Crew-Vehicle Systems Research Facility, a unique national research resource, was designed for the study of human factors in aviation safety. This facility is used to analyze performance characteristics of flight crews, formulate principles and design criteria for future aviation environments, evaluate new and contemporary air traffic control procedures, and develop new training and simulation techniques required for the continued technical evolution of flight systems.

2.4.8. FLUID MECHANICS LABORATORY, N-260

An entirely new Computational Fluid Dynamics (CFD) method for predicting hover performance was developed in this facility. This CFD method is the first to predict the freely convecting wake system of a hovering rotor without any numerical dissipation errors. As a result, it is now possible to analyze the hover characteristics of highly innovative rotor designs routinely.

2.4.9. RESEARCH FACILITY, N-223

This facility supports materials development for thermal protection systems and plasma experiments.

2.4.10. 3.5-FOOT HYPERSONIC WIND TUNNEL AUXILIARIES, N-229A

This facility contains two large (5,500-horsepower) reciprocating compressors and the auxiliary equipment required to operate the compressors. Included in N-229A is the control room for distribution of high-pressure air across ARC, a mechanic shop, a switchgear room, a welding shop, and a boiler room. This facility is currently mothballed.

2.4.10.1. Mars Unit, N-242

This facility supports testing in a small wind tunnel simulating surface conditions on Mars. It also houses production of thermal protection tiles primarily used in support of the arc jet facility.

2.4.11. OUTDOOR AERODYNAMIC RESEARCH FACILITY, N-249

Originally built in 1969 and upgraded in 1994, the Outdoor Aerodynamic Research Facility is currently mothballed. It was used for static testing of V/STOL models and rotary wing models, for acoustic testing, and for the analysis of aircraft models prior to testing in the 40- by 80-foot or 80- by 120-foot wind tunnels.

The Outdoor Aerodynamic Research Facility consists of an open-air test facility with a model mounting test pad, data acquisition equipment, control room, and other necessary support equipment for remote model or aircraft operation.

2.4.12. 12-FOOT PRESSURE WIND TUNNEL, N-206 AND N-206A

Restored in 1994, this tunnel was the only large-scale, pressurized, low turbulence, subsonic wind tunnel in the United States. It provided unique high-Reynolds number testing capabilities for the development of high-lift systems on commercial transport and military aircraft, and for high angle-of-attack testing of maneuvering aircraft. This facility was closed in 2003 due to budgetary constraints.

2.4.13. BALANCE CALIBRATION LABORATORY, N-207

Operations at the lab include calibrating balances for the ARC Wind Tunnels, as well as for outside projects. ARC recently finished modifications on the Automated Balance Calibration Machine. The lab's current inventory of machine-to-balance adapters can accommodate 6.4- to 10-centimeter (2.5- to 4-inch) balances. Work is currently in progress to accommodate single-piece balance configurations, as well as smaller TASK balances. The machine is a unique tool-in-wind-tunnel balance calibration technology. It can generate simultaneous combinations of three forces and three moments within its load envelope. Without the physical limitations of dead-weight manual loading, the Automated Balance Calibration Machine can be used to bring calibration load schedules closer to real tunnel load conditions, thus increasing the accuracy of the calibration. This facility is closed.

2.4.14. UNITARY PLAN WIND TUNNEL, N-227 AND N-227A-D

The Unitary Plan Wind Tunnel facility is the most heavily used wind tunnel in all of NASA. Every major commercial transport and almost every fighter built in the United States over the last 50 years has been tested in this tunnel. In addition, models of the space shuttle and of the Mercury, Gemini, and Apollo capsules were tested here. More than 1,000 test programs have been conducted in these tunnels, totaling approximately 60,000 hours of operation.

This facility is a unique system of wind tunnels comprised of three test sections: the 11- by 11-Foot Transonic Wind Tunnel, the 9- by 7-Foot Supersonic Wind Tunnel, and the 8- by 7-Foot Supersonic Wind Tunnel. Subsonic, transonic, and supersonic aerodynamics research is performed at this facility. The major common element of the tunnel complex is its electric power plant, which consists of four interconnected motors capable of producing a total of 134-megawatt (180,000-horsepower) continuously or 161-megawatt (216,000-horsepower) for 1 hour.

The wind tunnel represents a unique national asset of vital importance to the nation's defense and its competitive position in the world aerospace market. In 1985, the Unitary Plan Wind Tunnel facility was designated as a National Historic Landmark by the National Park Service because of "its significant associations with the development of the American Space Program." The Unitary Plan Wind Tunnel facility has undergone major modernization, including automatic controls, a new data system, and other improvements to increase productivity.

2.5. FACILITIES IN CODE T: OFFICE OF THE DIRECTOR OF INFORMATION SCIENCES AND TECHNOLOGY

2.5.1. NUMERICAL AERODYNAMIC SIMULATION FACILITY, N-258

Since 1984, the Numerical Aerodynamic Simulation Facility has provided innovative supercomputing technology solutions and services for aeronautics scientists and engineers at NASA, universities, and in industry. The Numerical Aerodynamic Simulation Facility plays a major role in NASA programs dedicated to researching, developing, and transferring information technology (IT) to support NASA's missions.

This facility houses unique supercomputing resources that are constantly being updated and augmented. These computers are used on a nationwide timesharing basis to perform calculation-intensive programs for simulation of aerodynamic flows, chemical reactions, and atmospheric physics. This building is home to NASA's Columbia Super Computer.

2.5.2. ARC JET COMPLEX, N-238, N-234, AND N-234A

ARC currently operates a variety of arc-heated facilities within the Arc Jet Complex. These facilities are used to generate flow environments that simulate the aerothermal environment that an object experiences when traversing the atmosphere of a planet. They are used primarily to test heat shield materials and thermal protection system components for planetary entry vehicles, planetary probes, and hypersonic flight vehicles, although other investigative studies are performed in some of these facilities. In the arc jet facilities, thermal protection system components are exposed to the aerothermodynamic heating conditions that they will encounter during high-speed flight.

The facilities of the Arc Jet Complex are located in Buildings N-234 and N-238. The Aerodynamic Heating Facility and the Turbulent Flow Duct Facility are located in Building N-234; the Panel Test Facility and the Interaction Heating Facility are located in Building N-238; Building N-234A houses the boiler for the Steam Vacuum System.

The arc jet facilities are serviced by common facility support equipment, including two direct-current power supplies, a steam-ejector vacuum system, a de-ionized water cooling system, high-pressure gas systems, a data acquisition system, and other auxiliary systems. The magnitude and capacity of these support systems distinguishes the Arc Jet Complex as unique in the aerospace testing world. In particular, the large power supply can deliver 75 megawatts for 30 minutes. High-power capability, in combination with the high-volume steam-ejector vacuum system, yields a unique suite of facilities that simulate high-altitude atmospheric flight on relatively large test objects.

2.5.3. HUMAN PERFORMANCE RESEARCH LABORATORY, N-262

Research at the Human Performance Research Laboratory focuses on human performance and automation in aerospace systems. Areas of study include human vision, audition, attention, motor control, fatigue, human factors maintenance, communication, team problem-solving, training, human workload, control theory, virtual reality, and virtual environments. Areas of development include: (1) computational models of human perceptual, cognitive, and decision systems; (2) perceptual optimization of visual displays and imaging systems; (3) three-dimensional auditory displays; (4) machine vision algorithms for autonomous vehicle control; (5) advanced human-centered IT; and (6) human factors expertise to address high-priority aerospace challenges.

2.5.4. AUTOMATION SCIENCES RESEARCH FACILITY, N-269

The Automation Sciences Research Facility provides an integrated environment for investigating the interaction between humans and highly automated systems. Within the Automation Sciences Research Facility, the neuro-engineering library is used to support intelligent flight control (neural networks applied to flight systems). The DARWIN testbed connects the wind tunnels with the aircraft manufacturers for better design and testing control and result dissemination. The intelligent mechanism laboratory has been the site of several field missions demonstrating remote/telecontrol and presence. The photonics laboratory supports the study of bacteriorhodopsin for optical processing.

N-269 also houses the Future Flight Central facility, administered by Code A. The Future Flight Central facility provides a 360-degree view/simulation of an air traffic control tower. Examples of current projects at this facility include: (1) implementation of terrain mapping visualization systems for remotely operated vehicles; (2) acquisition, processing, and visualization of acoustic data in wind tunnel tests; and (3) investigation of bacteriorhodopsin (an experimental protein) as an optical processing and sensing medium.

2.6. FACILITIES IN CODE J: OFFICE OF THE DIRECTOR OF CENTER OPERATIONS

2.6.1. TECHNICAL SERVICES, N-220

The Development Machining and Electromechanical Instrumentation Branch, in Building N-220, is a branch of the Aeronautics and Space Flight Hardware Development Division. Machining, instrumentation, mechanical inspection, electronic, and CAD/CAM services occur at this facility. This facility primarily develops prototype hardware for the ARC Research Community. That hardware includes experimental scientific apparatus for shuttle or airborne missions, aerospace wind tunnel models, facility modifications, and biosensors. The personnel at this facility consist of highly skilled engineering technicians that assist with designs and perform all fabrication on complex scientific instruments and models.

2.6.2. MODEL DEVELOPMENT, ADVANCED COMPOSITES GROUP, N-212

This facility houses the Advanced Composites Group. The Advanced Composites Group is a technical support group for all research disciplines at ARC. Its capabilities include composite fabrication, plastic fabrication, and other non-metallic fabrication processes. The Advanced Composites Group contributes to the design and manufacturing of a variety of test equipment and models. The Advanced Composites Group's expertise with many materials and processes has made this facility vital to the success of many high-profile projects at ARC. This facility contains spray booths for finish applications, autoclaves for composite fabrication, and many machine tools.

2.6.3. IMAGING TECHNOLOGY LABORATORY, N-203

This facility contained offices and laboratories for the processing of color (AR-5) and black and white aerial film for the Airborne Remote Sensing Research Program. Four persons operate and maintain the 1811 and 11CM Versamat film processors located on the second floor and the effluent treatment plant located in the basement. Photo processing no longer takes places within this facility. Facility currently houses administrative support staff for center.

2.6.4. MAGNETIC STANDARDS LABORATORY AND TEST FACILITY, N-217 AND N-217A

Two magnetic test facilities are located at ARC in Buildings N-217 and N-217A. They were used infrequently during the late 1990s and were being considered for closure in 2000. The 3.7-meter (12-foot) facility located in Building N-217 is designed to calibrate magnetic sensor systems, determine magnetic cleanliness, and measure low-frequency electromagnetic radiation of items not exceeding 1 meter (3.3 feet) in any dimension. The 6-meter (20-foot) coil facility, located in N-217A, was built to accommodate testing of items that are too large for the 3.7-meter (12-foot) facility. In addition to the capabilities of the 3.7-meter (12-foot) facility, the 6-meter (20-foot) facility can duplicate the strength and direction of the earth's magnetic field anywhere on earth, in earth orbit, or in deep space. The ambient field in the working area of the coils can be canceled to permit engineering or biological studies in near-zero fields. Noninvasive measurements of the magnetic field produced by the human heart, for example, were performed in this facility. This facility has measurement sensitivities of less than 1 microgauss.

2.6.5. CENTRAL COMPUTER FACILITY, N-233 AND N-233A

The Central Computer Facility houses the computer and networking systems that provide the basic IT infrastructure for the day-to-day operation of ARC. Included in this suite of systems are a large number of UNIX–based servers that provide the center's email and messaging services, the internal (intranet) web sites, and external web sites used for public outreach. This facility also houses the Network Operations Center from which the center's ARCLAN campus network is managed and operated, along with its related server systems and user help desk. The Central Computer Facility also houses ARC's business data processing and database systems, which support personnel and financial resource management functions throughout the center. The N-233A wing of this facility houses an archival data storage system used by the Numerical Aerospace Simulation Supercomputer Facility (located in N-258). This storage system utilizes robotic magnetic tape storage "silos" to provide very high-capacity file storage for their R&D users. This storage system is linked to the N-258 supercomputers via a high-speed fiber optic communications system. In addition, N-233A houses an IT systems development and integration laboratory supporting the activities of the Central Computer Facility (Code JT) and the Code I advanced computer-networking projects.

2.6.6. Motor Pool, N-251

The Motor Pool contains facilities for the management of ARC's transportation needs. It includes a fuel station, offices, equipment repair bays, vehicle wash area, and parking areas for conducting the operation, maintenance, and repair of the diverse vehicular fleet.

2.6.7. Telecommunications Facility N-254 (Code J)

This facility houses office space and telecommunications equipment. It originally had an area of 7,967 square feet. A 2,000 square foot addition was constructed in 2003.

2.6.8. Facility Supply Support Center N-255 (Code J)

This 81,639 square foot building houses the postal and supplies operations for Ames Research Center.

2.6.9. Disaster Area Relief Team, N-267

This 6,367 square foot building houses the Disaster Area Relief Team (DART) facilities. Training and exercise drills are conducted at this facility.

2.7. FACILITIES IN CODE JQ: OFFICE OF THE DIRECTOR OF SAFETY, ENVIRONMENTAL, AND MISSION ASSURANCE

2.7.1. Hazardous Substances Transfer Site, N-265

This facility serves as an accumulation and packaging area for hazardous wastes generated at various locations throughout the center. Hazardous wastes are accumulated and packaged in areas segregated by hazard class and type.

2.7.2. Industrial Wastewater Treatment Facility, N-271

The Industrial Wastewater Treatment Facility (IWWTF) was recently constructed to remove metals and dissolved solids from industrial wastewater and from groundwater, enabling treated effluent to be used as makeup water in the boiler for the Arc Jet Facility and in the Unitary Plan Wind Tunnel cooling tower. Treatment and reuse of ARC's industrial wastewater, and use of treated groundwater, lessen the demand for San Francisco Water Department (SFWD) potable supply, as well as substantially decreasing discharges to the Palo Alto Regional Water Quality Control Plant and Stevens Creek. Additional information on the IWWTF is provided in Chapter 15 ("Public Services, Utilities, and Energy").

2.8. FACILITIES IN CODE S: OFFICE OF THE DIRECTOR OF ASTROBIOLOGY AND SPACE RESEARCH

2.8.1. 20-G CENTRIFUGE, N-221A

The 20-G Centrifuge is 17.7 meters (58 feet) in diameter and can be used to evaluate flight hardware and test the effects of hyper-gravity on humans, other animals, and plants. Mounted on the centrifuge are three enclosed cabs. Cab A, mounted at one end of the rotating arm, contains a modified jet fighter ejection seat in which a human volunteer sits during tests. Cab B, at the other end of the rotating arm, contains a swing frame often used for non-human subjects or can be configured to meet an investigator's needs. Cab C, located near the center of the arm (the center of rotation), can be adapted to an investigator's needs or can be used as a near-center control for angular velocity or to study the effects of gravity gradients. The 20-G Centrifuge is capable of producing forces up to 20 times that of terrestrial gravity. During centrifuge operations, a combination of 47 control and 56 instrumentation slip rings allows control of onboard experiments from the control room and communication between control room operators and onboard subjects. The centrifuge speed is computer-controlled, allowing for the development of preprogrammed gravity profiles. A programmable logic controller monitors all critical mechanical and electrical systems to ensure that the systems are within design specification limits.

2.8.2. BIOSCIENCES LABORATORY, N-236 AND N-236A-E

The Biosciences Laboratory is used for biomedical research and animal care.

2.8.3. LIFE SCIENCES RESEARCH LABORATORY, N-239 AND N-239A

The Life Sciences Research Laboratory contains the human environmental test facility and environmental chamber. Research conducted at this facility includes, biomedical, extraterrestrial research, ecosystem science, closed ecological life-support systems (CELSS), nanotechnology research, and search for extraterrestrial intelligence (SETI). Some laboratories in this facility are operated by Code A personnel.

2.8.4. AIRBORNE MISSIONS AND APPLICATIONS LABORATORY, N-240 AND N-240A

The Airborne Missions and Applications Laboratory is occupied by the Life Sciences Division offices, the C-130 Data Facility, and the wet chemistry lab. This facility contains offices and laboratories supporting the NASA Space Station Biological Research Payload Office, which performs planning, testing, and hardware integration for life sciences payloads. Biology laboratories and a high-bay test area are used for experiment verification tests in which payload experiments are performed by the experiment science teams and space lab crew using flight hardware, ground operations procedures, and space-lab crew procedures. Flight hardware is prepared and shipped from this site to Kennedy Space Center. The wet chemistry laboratory houses a variety of testing equipment for environmental testing. The wet chemistry laboratory is equipped with thermograin metric analysis and digital scanning calorimetry capabilities for materials characterization. Projects of interest that have been conducted by the materials group in the wet chemistry area include hygrothermal analysis of composite specimens and exposure testing of aluminum.

2.8.5. Vestibular Research Facility, N-242

The Vestibular Research Facility contains state-of-the-art equipment for ground-based studies of vestibular function (which affects one's sense of balance). This facility hardware enables the study of responses to smooth, linear motion, or to combinations of linear and angular motion over the frequency range of natural head movement.

The Vestibular Research Facility permits the study of how complex linear and/or rotational accelerations are transduced, encoded by the vestibular system, and processed by the brain. Interactions between linear and angular vestibular stimuli, and visual and proprioceptive inputs (peripheral, central, and motor), are examined using electrophysiological, reflexive, and behavioral methods.

2.8.6. Space Projects Facility N-244

The Space Projects Facility contains the offices and laboratories for developing and managing space projects. It includes facilities for conducting mission operations and laboratories for developing infrared detectors, cryogenics, control systems, communication systems, data systems, and other support systems and experiments for space projects. It also includes a clean room facility and an environmental test laboratory.

2.8.7. Space Sciences Research Laboratory, N-245

The Space Sciences Research Laboratory is dedicated to research in astrophysics, exobiology, and planetary science. These research programs are structured around the study of origins and evolution of stars, planets, planetary atmospheres, and biological organisms.

The Space Science Division's programs include: (1) the study of interstellar gas and dust that form the raw material for stars, planets, and life; (2) the processes of star and planet formation; (3) the search for planetary systems around other stars; (4) the evolution of planets and their atmospheres; (5) the structure, dynamics, and chemistry of planetary atmospheres; (6) the origin of the biogenic elements and molecules and their distribution in space; (7) the origin of life and its early evolution on Earth; and (8) the search for past or present life throughout the solar system.

2.8.8. BIOMEDICAL RESEARCH FACILITY, N-261

The Biomedical Research Facility is utilized for neuroscience research. This facility contains a darkroom, electron microscopy facilities, computer areas, testing booths, and surgery facilities.

2.9. FACILITIES IN CODE Y: AEROFLIGHT DYNAMICS DIRECTORATE, U.S. ARMY AVIATION AND MISSILE COMMAND

2.9.1. ARMY AEROMECHANICS LAB AND 7- BY 10-FOOT WIND TUNNELS NO. 1 AND 2, N-215 AND N-216

The tunnels are closed circuit, low speed, and pressurized to 1 atmosphere. Tunnel No. 1 is used for research in support of low-speed aerodynamics, using small-scale aircraft, V/STOL aircraft, and space vehicle reentry body models. Wind speeds within the tunnel are continuously variable up to 402.5 kilometers per hour (250 miles per hour). This facility is currently not in use.

2.9.2. MODEL PREPARATION AREA, N-216A AND B

This area is a shop used in the development of models to be run in the 7- by 10-Foot Wind Tunnel and the development of parts for the tunnel.

2.10. OTHER FACILITIES AT NASA AMES RESEARCH CENTER

2.10.1. NATIONAL FULL-SCALE AERODYNAMIC COMPLEX, N-221 AND N-221B – AIR FORCE LEASE

The National Full-Scale Aerodynamics Complex (NFAC) is the largest wind tunnel complex in the world and consists of the 40- by 80-Foot Wind Tunnel, 80- by 120-Foot Wind Tunnel, and Outdoor Aerodynamic Research Facility. The National Full-Scale Aerodynamics Complex was primarily used to determine the low- and medium-speed aerodynamic characteristics of high-performance aircraft, rotorcraft, and fixed wing, powered-lift V/STOL aircraft. Operated and used by NASA, the National Full-Scale Aerodynamics Complex was also used by industry, the Department of Defense, and other government agencies. The NFAC is currently being used by the Air Force. The 40- by 80-foot wind tunnel has been determined to be eligible for listing in the National Register of Historic Places.

2.10.1.1. Hangar 1

Hangar 1, built in 1933, is the dominant structure at ARC. The 35,767-square-meter (385,000-square-foot) building was originally built for maintenance and storage of lighter-than-air craft. More recently, it has been used for instruction, administration, and aircraft maintenance. Plans exist to develop Hangar 1 into Space World Hangar 1, a nonprofit educational resource. Hangar One was recently found to be the source of polychlorinated biphenyl (PCB) contamination of sediments transported by stormwater runoff. The Navy has agreed to make Hangar One part of the Navy's site remediation program and began work on Hangar 1 in 2003. Hangar 1 is closed pending successful remediation of PCB contamination.

2.10.2. HANGARS 2 AND 3

Hangars 2 and 3, built in 1942, are 32,226 square meters (346,875 square feet) and 40,296 square meters (433,738 square feet) respectively. Both hangars today contain office space and are used for aircraft maintenance and storage.

2.10.3. RUNWAYS

The two parallel runways at the airfield are situated northwest to southeast between Hangar 1 and Hangars 2 and 3. The runways were constructed in 1933. Their area is 150 hectares (370 acres).

2.10.4. MAINTENANCE AND OTHER SUPPORT FACILITIES

Numerous other facilities include ordnance storage, maintenance, personnel support facilities, housing, public works facility, boilers, cafeteria, other laboratories, and administrative offices.

2.11. RESIDENT AGENCIES AT AMES RESEARCH CENTER

Resident agencies at ARC include the California Air National Guard; U.S. Army; Federal Bureau of Alcohol, Tobacco and Firearms; and Federal Emergency Management Agency. Research partners include Carnegie Mellon University (CMU), Clarke University, San Jose State University, the University of California at Santa Cruz (UCSC), and numerous business and industry concerns. Table 2-2 lists resident agencies and research partners along with their key activities and/or areas of research.

Table 2-2 ARC Research Partners

Entity	Activities/Area of Research
Carnegie Mellon University	West Coast campus, opened 2003; instruction, high-dependability computing research
University of California, Santa Cruz	University of California Silicon Valley Center; opportunities for students and researchers to work with NASA scientists on collaborative projects
San Jose State University	California State University Metropolitan Technology Center; classroom and office use
Space Technology Center (San Jose State University, Stanford University, Santa Clara University, Utah State University, California Polytechnic University, and Aerospace Corporation)	Microsatellite development, education for the space program
Clarke University	Unmanned Aerial Vehicles (UAV) Applications
Foothill and DeAnza Community College District	
National Center for Women in Science and Technology, Engineering, and Mathematics	Research partner
National Association for Equal Opportunity in Higher Education	Research partner
California Air and Space Educational Foundation	Development of Space World Hangar One
AITek, Inc.	Human-machine interface technology
ARACOR	Scanning systems for DHS
Aramira	Distributed computing among mobile platforms
Changene	Bone density growth
Conceptlabs	Technology assessment/engineering services/IT
Defouw Engineering	Biomedical devices
Digiproofs	Digital imaging
DMJM Technology	Architectural and engineering services
e4Xchange	Mental health scenario planning/Centers for Disease Control and Prevention (CDC) Small Business Innovation Research (SBIR) I
IISC	Neuro networks/data packet transmission optimization
Intelligence Inference Systems, Inc.	Soft computing and intelligent mechanisms
ION America	Fuel cells
Jivalti	Research on grid/Jivalti library
Kentucky Science and Technology Corporation	IT research projects
Omnivergent Communication Corporation	Next generation network
Photozig, Inc.	Integrated digital photo technology
Puresense Environmental, Inc.	Environmental health monitoring
Tibion	Muscle augmentation technology

California Air National Guard has completed construction of a 70,000 square foot hangar as part the Short Range master Plan for the 129th Rescue Wing.

2.12. NASA RESEARCH AIRCRAFT

ARC is home to several specially modified research aircraft, including an NAH-1S Cobra, a UH-60 Black Hawk, the Rotorcraft-Aircrew Systems Concepts Airborne Laboratory, and an OH-58C Kiowa, all of which are discussed below. The ARC aircraft inventory experienced a significant reduction in 1997, with the following aircraft permanently relocated to NASA Dryden Flight Research Center in Edwards, California: ER-2, BE200 King Air, YAV-8B Harrier, Lear 24B, C-130, DC-8, YO-3A, and T-38 Talon.

The Ames Airborne Science and Flight Research Division (under Code A) is responsible for the management and implementation of all Ames aircraft operations, including modification, maintenance, inspection, and flight.

Stratospheric Observation For Infrared Astronomy (SOFIA) is an airborne laboratory encompassing a 2.5 meter telescope within a modified Boeing 747 SP Aircraft. It is the largest airborne telescope in the world, and from its 41,000-foot vantage point, astronomers will be above more than 99 percent of the infrared absorbing atmospheric water vapor that limits what can be studied using ground-based telescopes. The aircraft will be deployed from Dryden Flight Center.

2.12.1. NAH 1S COBRA

Also called the Flying Laboratory for Integrated Test and Evaluation, this NAH-1S Cobra includes an Apache Pilot Night Vision System. The aircraft is equipped with head down and helmet-mounted displays, voice recognition and synthesis computers, flight symbology graphics generator, imaging sensors, and head tracker. The aircraft has onboard equipment that can record helicopter performance data, human response data, visual forward looking infrared (FLIR) imagery, color imagery, and audio for human-machine integration research. The aircraft has recently been used for drivetrain health and usage monitoring studies.

2.12.2. UH-60 PAVE HAWK

The Pave Hawk is a twin-turbine, single main rotor modified for aeronautical research. Research results on the helicopter have been used to obtain a comprehensive, accurate, documented airloads database over the complete operating limits of the UH-60 rotor system. This database is currently being used to increase understanding of rotor behavior, refine and validate analysis tools, and design improved rotorcraft. The UH-60 was also recently used by Code ARH researchers to study the effects of slung loads on system stability and handling qualities, including the development of simulation models and flight test techniques, which offer the potential for significant cost reductions in load clearance and certification.

2.12.3. Rotorcraft-Aircrew Systems Concepts Airborne Laboratory

The Rotorcraft-Aircrew Systems Concepts Airborne Laboratory, a highly modified UH-60A Black Hawk helicopter, is a new rotorcraft research facility under development at ARC. Its purpose is to provide the capability for in-flight investigations of advanced control, guidance, and display systems that allow both high agility and maneuverability and the ability to fly close to the ground in poor visibility conditions. The Rotorcraft-Aircrew Systems Concepts Airborne Laboratory contains a full-authority, programmable, digital fly-by-wire control system, advanced sensors/strain gauges in the fixed and rotating systems for health and usage monitoring research, and active side-stick controllers for envelop limiting and cueing work. This facility is presently used by Code ARH scientists and by industry through the National Rotorcraft Technology Center.

2.12.4. OH-58C Kiowa

The Kiowa is a two-seat, side-by-side, single-engine helicopter used at ARC for pilot proficiency and chase operations during the conduct of flight tests.

2.13. SIGNIFICANT ASPECTS SUMMARY

Facilities', buildings', and areas' use and potential environmental impacts are summarized in Table 2-3.

Table 2-3 Significant Aspects Summary for NASA Ames Research Center

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
N-200	1943 2461 square meters (26,485 square feet)			Hazardous Materials	Flammable liquids, corrosives, other regulated materials
N-202 CODE DK - Commercial Technology Office CODE DXC - Communication Branch	1950 2,470 square meters (26,508 square feet)	Space Technology	Physical sciences laboratory: sensor development, intelligent systems, thermal protection systems, life support technology	Hazardous Materials	Corrosives
N-203 CODE SG - Earth Science Division CODE JIT - Documentation Technology Division CODE CF - Financial Management Division	1942 2,144 square meters (23,080 square feet)	Imaging Technology Laboratory	Photo-development	Hazardous Materials	Oxidizers/peroxides, corrosives, poisons, other regulated materials
				Hazardous Waste	Batteries
				Pollution Prevention	Beneficial: Photolaboratory treatment systems reduce hazardous waste and industrial wastewater

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
N-204 and N-204A CODE ASF – Thermo-Physics Facilities	1955 1374 square meters (14,782 square feet) 587 square meters (6,314 square feet)	Vertical Gun Range	Photo-development	Air Pollution	POCs (wipe cleaning)
				Hazardous Materials	Explosives, gasses, flammable liquids, poisons
				Radiation Sources	Class 4 laser
				Hazardous Waste	Paints
N-206 and N-206A CODE FOF - Aeronautical Facilities Engineering Branch CODE FOW - Wind Tunnel Operations Branch	1946 and 1969 4,966 square meters (53,436 square feet) 1,092 square meters (11,751 square feet)	12-Foot Pressure Wind Tunnel	Low-turbulence testing	Air Pollution	Coatings usage (VOCs), POCs (wipe cleaning)
				Industrial Wastewater	Wind tunnel cooling tower blowdown
				Hazardous Materials	Gasses, flammable liquids, corrosives, other regulated materials
				PCBs	Transformer (> 500 ppm)
				Storage Tanks	8 ASTs (hydraulic oil, 60-850 gal.)
				Pollution Prevention	Beneficial: CFC Replacement, Minimization of hazardous waste
				Energy Efficiency	Beneficial
				Noise and Vibration	Occupational Noise

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
			Radiography	Recycling	Beneficial: Silver recycling
N-207	1946 2,531 square meters (27,239 square feet)			Air Pollution	Coatings usage (VOCs), POCs (wipe cleaning)
N-207A CODE FOF - Aeronautical Facilities Engineering Branch	1949 723 square meters (7,778 square feet)	Balance Calibration Laboratory	Physical Sciences Laboratory	Hazardous Materials	Gases, flammable liquids, corrosives, other regulated materials
				Hazardous Waste	Solvents, adhesives/catalysts
				PCBs	Transformer (< 50 ppm)
N-210 CODE AR - Army/NASA Rotorcraft Division	1947 7,746 square meters (83,350 square feet.	Flight Systems Research Laboratory	Physical Sciences Laboratory	Air Pollution	POCs (wipe cleaning)
				Hazardous Materials	Corrosives, flammable liquids, other regulated materials
				Industrial Wastewater	HVAC blowdown
				Hazardous Wastes	Batteries
				PCBs	Three transformers (>500 ppm)

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
N-211	1945 17.849 square meters (192,056 square feet)			Air Pollution	VOCs (spray painting), POCs (wipe cleaning), POCs (wipe cleaning)
				Hazardous Waste	Non-halogenated oil, oil filters, contaminated solids; batteries; cleaners; fuel filters
				Storage Tanks	3 ASTs (diesel, 50 gal.; JP-8, 5,000 and 19,500 gal.)
N-212 CODE JMC –	1950 1,478 square meters (15,906 square feet)	Model Development	Model Shop	Air Pollution	Coatings usage (VOCs), POCs (wipe cleaning)
				Hazardous Materials	Gases, flammable liquids, corrosives, poisons, other regulated materials
				Hazardous Wastes	Paints, paint thinner, and paint-contaminated solids and rags; batteries; adhesives; aerosol cans
				Pollution Prevention	Source reduction of paint booth debris (paint sprayer and liquid management system)
N-213	1950 9,351 square meters (100,622 square feet)			Hazardous Materials	Flammable liquids, corrosives, poisons, other regulated materials
				Radiation Sources	Class 4 lasers
				Storage Tanks	1 AST (diesel, 350 gal.)

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
				Hazardous waste	Batteries; misc. laboratory reagents and chemicals
				Air Pollution	POCs (wipe cleaning)
N-214	1942 261 square meters (2,804 square feet)			Hazardous Materials	Flammable liquids, corrosives, poisons, oxidizer/peroxide, other regulated materials
				Industrial Wastewater	Compressor cooling water
N-215	1941 1,607 square metes (17,295 square feet)			Air Pollution	Solvent usage, POCs (wipe cleaning)
				Hazardous Waste	Medical waste, batteries
				Hazardous Materials	Flammable liquids, gases, corrosives, poisons, other regulated materials
				Storage Tanks	1 AST (diesel, 175 gal.)
N-216 and N-216A-B	1941 and 1973 520 square meters (5,598 square feet) 484 square meters (5,203 square			Air Pollution	Solvent usage, POCs (wipe cleaning)
				Industrial Wastewater	Laser cooling water
				Radiation Sources	Class 3 and 4 lasers
				Hazardous Wastes	Solvents, oily rags
				Hazardous Materials	Flammable liquids, corrosives, poisons, gases, other regulated materials
				PCB Management	Transformer (<50 ppm PCBs)

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
	feet) 457 square meters (4,917 square feet)			Pollution Prevention	Motor coolant water recycling
N-217 and N-217A CODE J - Center Operations CODE JF - Facilities, Logistics and Airfield Management	1969 and 1972 78 square meters (844 square feet) 263 square meters (2,829 square feet)	Magnetic Standards Laboratory and Test Facility	Calibrate magnetic sensors, magnetize and demagnetize instruments, simulate magnetic field	PCBs	Transformer (<50 ppm PCBs)
				Pollution Prevention	Coolant Recovery System (recycles used machine coolant – 3,000 gallons/year)
N-218	1941 2,926 square meters (31,488 square feet)			Hazardous Materials	Flammable liquids, poisons, corrosives, other regulated materials, medical waste
				Radiation Sources	Sealed sources (Ra-226, Cs-137, Am-241, Fe-55, Cd-109, Ni-63)
				Storage Tanks	1AST (oil, 2,000 gal., inactive)
				Hazardous Waste	Batteries, solvents, oil
				Air Pollution	Coatings usage (VOCs), POCs (wipe cleaning)

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
N-220 CODE FMX - Development Machining and Electromechanical Instrumentation Branch	1940 3,729 square meters (40,122 square feet)	Technical Services	Development machining and electromechanical instrumentation; develops prototype hardware	Air Pollution	Solvent usage (permitted equipment), coatings usage (VOCs), parts cleaner, POCs (wipe cleaning)
				Hazardous Materials	Gases, flammable liquids, corrosives, poisons, other regulated materials
				Hazardous Waste	Batteries, oil-contaminated water and rags, inorganic compounds, contaminated solids, solvents and adhesives
				PCBs	Three transformers (Tag #154->500 ppm PCBs, all others <50 ppm PCBs)
				Noise and Vibration	Community and occupational noise
				Pollution Prevention	Waste-minimization reusable steel grit to remove lead-based paint; milling machine cooling water recycling
				Recycling	Acoustic foam
N-221 and N-221B CODE DQH - CODE FOI - Wind Tunnel Systems Branch	1944 and 1985 14,992 square meters (161,312 square feet)	40- by 80-Foot Wind Tunnel and 80-by 120-Foot Wind Tunnel	Low-speed testing and configuration validation	Hazardous Materials	Gasses, corrosives, flammable liquids, oxidizers, poisons, other regulated materials
				Air Pollution	NOx, combustion products (engine testing), coatings usage (VOCs), POCs (wipe cleaning)
				Radiation Sources	Class 4 laser

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
CODE FOF - Aeronautical Facilities Engineering Branch CODE FOW - Wind Tunnel Operations Branch	1,932 square meters (20,783 square feet)			Storage Tanks	5 ASTs (hydraulic oil, 350 – 3,000 gal), 1 AST (jet fuel, 500 gal.)
				Hazardous Wastes	Mercury-containing wastes, fluorescent tubes, batteries, paints, oily water
				Industrial Wastewater	Chiller condensate
N-221A CODE SLE - Payloads and Facilities Engineering Branch	1964 602 square meters (6,474 square feet)	20-G Centrifuge	Centrifuge	PCBs	28 transformers (Tag # 6 52 ppm PCBs, Tag #4 54 ppm PCBs, Tag #24 201 ppm PCBs, Tag #32 55 ppm PCBs, all others <50 ppm PCBs)
				Noise and Vibration	Occupational Noise
N-223 CODE ASM - Aerosol Laboratory	1955 2218 square meters (23, 870 square			Air Pollution	POCs (wipe cleaning)
				Hazardous Materials	Corrosives, flammable liquids/solids, gasses, poisons, oxidizers, other regulated materials

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
Code ASN – Plasma Laboratory	feet)			Storage Tanks	1 AST (diesel, 85 gal.)
				Stormwater	Display aircraft washing (oils/grease, heavy metals)
				Hazardous Wastes	Contaminated solids, solvents, corrosives, batteries, mercury-containing wastes, ethylene glycol, organics
N-225B	1975 (Substation)			Storage Tanks	1 AST (oil, 1,000 gal.)
N-226	1964 3,144 square meters (33,832 square feet)			Hazardous Materials	Gasses, flammable liquids, oxidizer/peroxides
N-227, N227A-D CODE FOF - Aeronautical Facilities Engineering Branch CODE FOW - Wind Tunnel Operations Branch	1955 5,440 square meters (58, 537 square feet) 1,750 square meters (18,825 square feet)	Unitary Plan Wind Tunnel	Aerodynamics testing	Hazardous Materials	Gases, flammable liquids, and corrosives, oxidizer/peroxide, poisons, other regulated materials
				Air Pollution	Coatings usage (VOCs), POCs (wipe cleaning)
				Radiation Sources	Class 4 laser
				Storage Tanks	14 ASTs (hydraulic and DTE oil, diesel, 80- 8,000 gal.)
				Hazardous Wastes	Batteries; non-halogenated oil, oil filters, oily rags, and oily water; kerosene; paints and solvents; contaminated solids; fluorescent tubes

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
	1,931 square meters (20, 774 square feet) 1,341 square meters (14,430 square feet) 917 square meters (9,871 square feet)			Industrial Wastewater	Wind tunnel cooling tower blowdown
				Conservation	Historical buildings
N-229 CODE ASF - Thermo-Physics Facilities Branch	1961 3,150 square meters (33,890 square feet)	Electric Arc Shock Tube	Physical Sciences Laboratory	Air Pollution	POCs (wipe cleaning)
				Hazardous Materials	Gases, corrosives, flammable liquids, other regulated materials
				Hazardous Wastes	Batteries, contaminated solids, organic compounds
				PCBs	Five Transformers (Rm. 156, Shop >500 ppm PCBs, all others <50 ppm PCBs)
				Radiation Sources	Class 4 laser
N-229A-B CODE FOF Aeronautical Facilities	1976 and 1978 2,249 square	3.5-Foot Hypersonic Wind Tunnel	Wind Tunnel Testing	Air Pollution	Coatings usage (VOCs), parts cleaner, POCs (wipe cleaning)
				Hazardous Wastes	Laboratory chemicals

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
Engineering Branch CODE ASF - Thermo-Physics Facilities Branch	meters (24,200 square feet) 460 square meters (4,947 square feet)			Storage Tanks	4 ASTs (300 – 4,000 gal., Fryqual, waste oil, waste oil/water)
N-230 CODE ASC - Computational Chemistry Branch CODE ASA - Reacting Flow Environments Branch	1960 3,034 square meters (32,650 square feet)	Physical Sciences Research Laboratory	Photophysics, materials research	Hazardous Materials	Gasses, flammable liquids, poisons, corrosives, other regulated materials
				Air Pollution	POCs (wipe cleaning)
				Hazardous Waste	Solvents
				Radiation Sources	Class 3B, 4 lasers
				Storage Tanks	6 ASTs (oil, 100 gal.)
N-231 CODE ASF -	1960 717 square meters (7,718 square feet)			Air Pollution	Solvent usage, POCs (wipe cleaning)
				Hazardous Materials	Flammable liquids, gasses, other regulated materials
N-233 and N-233A CODE JT - Applied Information Technology Division	1960 and 1973 5,636 square meters (60,642 square feet)	Central Computer Facility	Advanced computer technology and systems	Hazardous Waste	Inorganic liquids, toner
				Hazardous Materials	Flammable liquids, corrosives, oxidizer/peroxide, other regulated material

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
	3,055 square meters (32,872 square feet)			PCBs	Transformer (<50 ppm PCBs)
				Pollution Prevention	Beneficial: Onsite treatment of hazardous waste
				Recycling	Ames Chemical Exchange
N-234 CODE ASF - Thermo-Physics Facilities Branch CODE ASM – Materials Characterization Lab	1962 2,489 square meters (26,781 square feet)	Thermal Protection Laboratory	High-enthalpy materials research; includes Aerodynamic Heating Facility and Turbulent Flow Duct Facility	Air Pollution	Coatings usage (VOCs), POCs (wipe cleaning)
				Hazardous Materials	Flammable liquids/solids, poisons, corrosives, gasses, oxidizer/peroxide, other regulated materials
				Radiation Sources	Class 3B, 4 lasers, X-ray diffraction machine (60 kV), electron microscope (25 kV)
				Hazardous Wastes	Batteries, organic compounds, solvents and cleaners
				Storage Tanks	1 AST (hydraulic oil, 100 gal.)
				Water Conservation	X-ray machine cooling water recycling
N-234A CODE ASF - Thermo-Physics Facilities Branch	1962 281 square meters (3,019 square feet)	Thermal Protection Laboratory Boiler	Boiler	Industrial Wastewater	Boiler scrubber, plenum spray maintenance
				Hazardous Materials	Gases, flammable liquids/solids, oxidizers/peroxides, poisons, corrosives, other regulated materials

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
CODE FOF - Aeronautical Facilities Engineering Branch				Hazardous Waste	Cooling tower sludge, used containers, barium compounds, organic compounds
				Air Pollution	NOx, combustion products (boiler for arc jet)
N-235	1964 1,152 square meters (12,400 square feet)			Hazardous Materials	Gasses, corrosives, other regulated materials
				Industrial Wastewater	Kitchen usages
N-236 CODE SLO - Science Payloads Operations Division CODE SLE - Payloads and Facilities Engineering Branch	1964 1,852 square meters (19,929 square feet)	Biosciences Laboratory	Biomedical research and animal care	Industrial Wastewater	Animal facility and cage cleaning
		Animal Research Incinerator	Incinerator	Air Pollution	Pathological waste incineration (permitted equipment)
				Hazardous Materials	Gases, flammable liquids/solids, corrosives, poisons, oxidizer/peroxide, other regulated materials
				Hazardous Waste	Medical/pathological waste, solvents, photo developer/fixer, organic compounds, contaminated solids, used containers
				Radiation Sources	Radiographic machines (76 kV, 150 kV)
				PCBs	PCB capacitors and solids

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
				Storage Tanks	2 ASTs (diesel, 80-120 gal.)
N-237 CODE AP - Aeronautical Projects and Programs Office CODE ASF - Thermo-Physics Facilities Branch CODE APM - Advanced Aircraft and Powered Lift Branch	1964 5,601 square meters (60,271 square feet)	Hypervelocity Free-Flight Facility	Aeroballistic range and large-scale Combustion Driven Shock Tunnel	Air Pollution	POCs (wipe cleaning)
				Industrial Wastewater	HVAC blowdown
				Hazardous Waste	Batteries
				Hazardous Materials	Gasses, flammable liquids, corrosives, poisons, explosives, other regulated materials
				PCB Management	Four transformers (<50 ppm PCBs)
				Radiation Sources	Class 4 lasers
				Pollution Prevention	Elimination of copper from treatment chemicals, oil/water separator
				Noise and Vibration	Occupational noise
N-238 CODE ASF -	1964 1,638 square	Arc Jet Complex	High enthalpy materials research;	Air Pollution	NO_x, combustion products (arc jet heating), coatings usage (VOCs), POCs (wipe cleaning)

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
Thermo Physics Facilities Branch	meters (17,629 square feet)		includes Panel Test Facility and Interaction Heating Facility	Hazardous Materials	Gasses, flammable liquids, poisons, corrosive, other regulated materials
				Hazardous Waste	Batteries, solvents and thinners, contaminated solids, oil and oily rags
			Laser Seeding	Radiation Sources	Class 3b, 4 lasers
N-239 and N-239A CODE SLR - Gravitational Research Branch CODE SSX - Exobiology Branch CODE SL - Life Sciences Division CODE SSR - Astrobiology Technology Branch CODE SLE - Payloads and Facilities	1965 and 1966 12,026 square meters (129,400 square feet) 2,801 square meters (30,136 square feet)	Life Sciences Research Laboratories	Human-machine biomedical and extraterrestrial research, ecosystem science, closed ecological life support systems	Air Pollution	POCs (wipe cleaning)
				Industrial Wastewater	HVAC blowdown, laboratory glassware washing machine, laboratory sinks
				Hazardous Materials	Gases, flammable liquids/solids, poisons, corrosives, oxidizer/peroxide, other regulated materials
				Hazardous Waste	Medical/pathological waste, batteries, organic and contaminated solids, organic liquids and solvents, inorganic acids, adhesives and misc. laboratory chemicals, non-halogenated oil and oily wastes, mercury-containing wastes, used containers, mercuric chloride
				Radiation Sources	Class 4 laser, sealed sources (Ni-63, H-3), electron microscopes (30 kV, 60 kV, 80 kV, 200 kV)

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
Engineering Branch Code AMS - Nanotechnology				PCBs	Transformer (< 50 ppm PCBs)
				Storage Tanks	2 ASTs (diesel, 500 gal.)
N-240 and N-240A CODE SLO - Science Payloads Operations Branch CODE SG - Earth Science Division	1965 and 1982 4,753 square meters (51,140 sq. ft.) 1,156 square meters (12,443 square feet)	Airborne Missions and Applications Laboratory	Research in life-sciences payload; Wet chemistry laboratory	Air Pollution	Ethylene oxide (sterilizer), POCs (wipe cleaning)
				Industrial Wastewater	HVAC blowdown
				Hazardous Materials	Gasses, flammable liquids/solids, poisons, corrosives, oxidizers, other regulated materials
				Radiation Sources	Electron microscope (20kV)
				Hazardous Waste	Batteries, paints and resins, ethylene glycol
N-241	1965 5,936 square meters (63,870 square feet)			Hazardous Materials	Flammable liquids, corrosives
				Storage Tanks	1 AST (diesel, 250 gal.)
				Hazardous Wastes	Oily water, contaminated solids, paints, batteries, lead-containing debris
				Industrial Wastewater	HVAC blowdown

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
N-242 CODE SGE - Ecosystem Science and Technology Branch Code ASF – Mars Unit Code ASM – Coatings Lab	1966 2,985 square meters (32,120 sq. ft.)	Vestibular Research	Ground-based studies of vestibular function;	Air Pollution	Solvent usage, POCs (wipe cleaning)
				Hazardous Materials	Gasses, flammable liquids/solids, corrosives, oxidizers, poisons, other regulated materials
				Hazardous Waste	Contaminated solids, batteries, used containers
				PCBs	Four Transformers (Tag # 104->500 ppm PCBs, Tag #100- 68 ppm PCBs, Tag #99 - 99 ppm PCBs, Tag #102 - 52 ppm PCBs)
				Pollution Prevention	Source Reduction of Paint Booth Debris (includes High Volume Low Pressure paint sprayer and Liquid Management System), 3 Air Compressor Oil/Water Separators
				Radiation Sources	Class 3b laser
N-243 and N-243A CODE ASF - Simulation Projects and Systems Branch CODE AF - Aviation Systems Research, Technology and Simulation	1967 58,701 square meters (631,623 sq. ft.) 883 square meters (9,503 square feet)	Flight and Guidance Simulation Laboratory	Flight safety, aeronautical handling qualities and flight dynamics	Air Pollution	VOCs (spray painting), parts cleaner, POCs (wipe cleaning)
				Industrial Wastewater	HVAC blowdown
				Hazardous Materials	Gasses, flammable liquids, oxidizers/peroxides, poisons, corrosives, other regulated materials
				Storage Tanks	1 AST (hydraulic oil, 800 gal.)

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
Division				Hazardous Waste	Batteries, paints, oily water and rags
N-244 CODE SF - Space Projects Division CODE SFE - Project Operations Branch CODE JEE -	1967 7,816 square meters (84,100 sq. ft.)	Space Projects Facility	Offices and laboratories for developing and managing space projects; computer systems, environmental test laboratory	Air Pollution	Coatings usage (VOCs), POCs (wipe cleaning)
				Industrial Wastewater	HVAC blowdown
				Hazardous Materials	Gasses, flammable liquids, poisons, corrosives, other regulated materials
				Hazardous Waste	Batteries, adhesives and solvents, oils
				PCBs	2 Transformers (<50 ppm PCBs)
				Radiation Sources	Class 3b lasers, sealed sources (Ra-226)
N-245 CODE JIL - Research Information Resources Branch CODE SSA - Astrophysics Branch	1970 7,500 square meters (80,705 sq. ft.)	Space Sciences Research Laboratory	Research in planetary atmospheres, planetary evolution, astrophysics, infrared astronomy, earth science and planetary geology	Air Pollution	POCs (wipe cleaning)
				Hazardous Wastes	Batteries, methanol, ethylene glycol, inorganic acids, compressed gasses and cylinders, oil, contaminated solids
				Hazardous Materials	Gases, flammable liquids/solids, corrosives, oxides/peroxide, poisons, other regulated materials
				Storage Tanks	1 AST (diesel, 110 gal.)

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
				Radiation Sources	Sealed sources (Ni-63)
				Industrial Wastewater	HVAC blowdown
				Noise and Vibration	Occupational Noise
N-246	1973 3,462 square meters (37,252 square feet)			Hazardous Materials	Gasses, flammable liquids, poisons, other regulated materials
				Air Pollution	Coatings usage (VOCs), POCs (wipe cleaning)
				Hazardous Wastes	Oil, batteries
				Industrial Wastewater	Model prep. cooling water
N-247	1975 1,002 square meters (10,777 square feet)			Air Pollution	NOx, combustion products (engine testing)
				Hazardous Wastes	Batteries
N-248 and N-248A-E CODE ARM- Space Projects Division	1973, 1973, 1976, 1987, and 1995 3,198 square meters (34,412			Air Pollution	Organic vapor (washrack oil/water separator), coatings usage (VOCs), POCs (wipe cleaning)
				Industrial Wastewater	Aircraft washrack
				Hazardous Materials	Gasses, flammable liquids, other regulated materials

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
	square feet) 386 square meters (4,148 square feet) 285 square meters (3,068 square feet) 533 square meters (5,738 square feet) 283 square meters (3,048 square feet) (N248E – washrack)			Stormwater	Petroleum hydrocarbons, oil and grease
				Pollution Prevention	Replace trichloroethylene use with aqueous cleaner
				Hazardous Waste	Batteries, oily water, JP-8, contaminated solids, non-halogenated oils, used containers, misc. paints and solvents, grease and lubricants, alodine, aerosol cans, misc. chemicals
N-249 CODE FOF - Aeronautical Facilities Engineering Branch	1975 308 square meters (3,314 sq. ft.)	Outdoor Aerodynamic Research Facility	Vertical take-off and landing	Air Pollution	POCs (wipe cleaning)
				Stormwater	Aircraft maintenance (oils, petroleum products, heavy metals)
				Energy Efficiency	Vehicle/Engine care

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
N-250 CODE AFS-	1974 248 square meters (2,671 square feet)	High-Pressure Facility		Hazardous Materials	Gasses, corrosives, flammable liquids
				Storage Tanks	1 AST (oily water, 4,000 gal.)
N-251	1977 367 square meters (3,945 square feet)			Hazardous Materials	Gasses, flammable liquids, other regulated materials
				Air Pollution	Fuel dispensing (VOC emissions), parts cleaner, POCs (wipe cleaning)
				Storage Tanks	2 USTs (4,000 gal., gasoline; 2,500 gal., diesel); 3 ASTs (65 gal., misc. oils and lubricants); 4 ASTs (500 – 2,000 gasoline and diesel fuel, inactive)
				Stormwater	Runoff from fleet parking (oil and grease, antifreeze, fuel); vehicle fueling; vehicle maintenance and wash rack (oil and grease, fuel, heavy metals, etc.)
				Hazardous Wastes	Diesel fuel, ethylene glycol, non-halogenated oil and oil filters, aerosol cans, used containers, oily waters and rags, gasoline, sump water, contaminated solids

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
				Industrial Wastewater	Vehicle wash rack
N-254	1980 555 square meters (5,967 square feet)			Hazardous Materials	Flammable liquids, corrosives, poisons
				Storage Tanks	1 AST (diesel, 800 gal.)
N-255	1978 7,587 square meters (81,639 square feet)			Hazardous Materials	Gasses, flammable liquids, corrosives, poisons, other regulated materials
				Stormwater	Runoff from fleet vehicle parking (oil and grease, antifreeze, fuel)
				Hazardous Wastes	Toner, misc. chemicals
				Air Pollution	Particulates (shredder, permitted equipment)
N-257 CODE AFS - Simulation Projects and Systems Branch	1982 1,630 square meters (17,535 sq. ft.)	Crew Vehicle Systems Research Facility	Human Performance Research/Computational Research	Hazardous Waste	Batteries, contaminated solids, oily rags
				Storage Tanks	2 ASTs (hydraulic oil, 220 – 400 gal.)

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
				Hazardous Materials	Gasses, flammable liquids/solids, poisons, other regulated materials
				Air Pollution	Coatings usage (VOCs), POCs (wipe cleaning)
N-258 CODE IN - Numerical Aerospace Simulation (NAS) Systems Division Code APS	1986 8,846 square meters (95,188 sq. ft.)	Numerical Aerodynamic Simulation Facility	Computational Research Cooling Tower	Hazardous Materials	Gasses, flammable liquids, corrosives and other regulated materials
				Hazardous Waste	Batteries, fluorescent tubes
				Storage Tanks	1 AST (diesel, 110 gal.)
N-259	1984 557 square meters (5,988 square feet)			Hazardous Materials	Gasses, flammable liquids, poisons, other regulated materials
				Air Pollution	Coatings usage (VOCs), POCs (wipe cleaning)
N-260 CODE APS - Experimental Physics Branch	1987 2,548 square meters (27,419 sq. ft.)	Fluid Mechanics Laboratory	Computational Fluid Dynamics	Hazardous Materials	Flammable liquids, other regulated materials
				Hazardous Waste	Organic compounds, paints and solvents, aerosol cans, non-halogenated oils, oily rags, batteries

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
				Air Pollution	Coatings usage (VOCs), POCs (wipe cleaning)
				Storage Tanks	1 AST (hydraulic oil, 150 gal.)
				Radiation Sources	Class 4 lasers
N-261 CODE SLO - Science Payloads Operations Branch	1989 1,539 square meters (16,560 sq. ft.)	Biomedical Research Facility	Neurosciences research	Hazardous Materials	Gasses, corrosives, other regulated materials
				Hazardous Waste	Organic liquids and solids, contaminated solids, used containers, solvents, batteries
N-262 CODE AFS - Human Factors Research and Technology Division	1990 6,846 square meters (73,658 sq. ft.)	Human Performance Research Facility	Research on advanced aeronautical and space systems	Air Pollution	POCs (wipe cleaning)
				Hazardous Waste	Batteries, solvents
				Hazardous Materials	Corrosives, flammable liquids/solids

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
N-263	1989 236 square meters (2,543 square feet)			Hazardous Materials	Flammable liquids, corrosives
				Storage Tanks	1 AST (diesel, 300 gal.)
N-265 CODE QE - Environmental Services	1988 431 square meters (4,638 square feet)	Hazardous Substances Transfer Site	Package Hazardous Wastes	Hazardous Materials	Gasses, flammable liquids/solids, oxidizers, poisons, other regulated materials
				Hazardous Waste	(Note: this location is a waste consolidator rather than a waste generator.)
				Storage Tanks	3 ASTs (oily water, 100 – 1,200 gal.)
N-267	1991 592 square meters (6,367 square feet)			Hazardous Materials	Gasses, flammable liquids, corrosives, oxidizer/peroxide, other regulated materials
				Radiation Sources	Sealed source (Ni-63)
				Stormwater	Runoff from fleet vehicle parking (oil and grease, antifreeze, fuel)
				Air Pollution	Particulates, combustion products (tub grinder and brush chipper and engines)

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
N-269 CODE IC - Computational Sciences Division	1990 5,645 square meters (57,643 sq. ft.)	Automation Sciences	Human/machine interactions; mapping (visual), acoustic and sensing information systems	Radiation Sources	Class 3b lasers
				Hazardous Waste	Batteries, contaminated solids, resins, adhesives, solvents
				Hazardous Materials	Flammable liquids, corrosives, other regulated materials
N-271	1999 (Pre-treatment plant)		Wastewater treatment plant	Hazardous Materials	Corrosives, other
				Hazardous Waste	Contaminated solids
				Industrial discharge	Pretreatment facility discharge to municipal sewer (29,510 gpd)
1, 46, 47 CODE JF - Facilities, Logistics and Airfield Management Division	Hangar 1: 1933 35,795 square meters (385,290 sq. ft.)	Hangars 1,2 and 3	Aircraft Maintenance, Storage and Defueling	Stormwater	Hazardous Materials/Waste Usage and Storage: Petroleum hydrocarbons, Oil and Grease
				Air Pollution	Organic vapor (aircraft wash oil/water separator)

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
	Hangar 2 and 3: 1942 32,226 square meters (346,875 sq. ft.) and 40,296 square meters (433,738 sq. ft.)			Hazardous Waste	Waste oil, oil filters, oil rags, oil-contaminated solids and water; batteries; contaminated fuel; paints, adhesives, and organic compounds; aerosol cans
				Storage Tanks	AST (50 gal. diesel, Bldg. 47)
				Historical Resources	Conserved: Shenandoah Plaza Historic District
ARC--All Facilities Center-wide Land	266,880 covered square meters (2,800,000 square feet) 448 acres			Air Pollution	Solvent wipe cleaning, architectural coatings, NOx and combustion products (boilers, emergency and mobile generators)
				Hazardous and Solid Wastes (RCRA and non-RCRA)	Debris and remediation waste (soil), used oil and oily water, PCB-containing wastes, jet fuel, laboratory and shop wastes (satellite and 90-day accumulation areas), universal wastes, solid (sanitary) waste
				Water Consumption	235,000 gpd (includes sanitary, industrial, cooling, and irrigation uses)
				Industrial/Sanitary Discharge	115,000 gpd
				Energy Consumption	27,700kWh/year

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
				Conservation/ Restoration	Vegetation, wetlands, fish, and wildlife preservation; historical resource preservation; groundwater and soil restoration
				Hazardous Materials	Sundry chemicals/usages (HMIS site inventory) not elsewhere listed
*Total Gross Floor Area primarily from Facilities' Building Layouts and from NASA Property Listing Report if data not available in Building Layouts. Date Construction Completed and Land areas from AMES Research Center/Moffett Federal Airfield Property Listing Report. Hazardous materials impacts from 4D-Hazardous Material Permits. Air impacts from 4-D Air Permits. Industrial wastewater discharges from Sunnyvale and Palo Alto permit application data. Only individual discharges in excess of 100 gpd (including both continuous and intermittent discharges/discharge potential) are identified. Hazardous wastes based on Biennial Report and Form A data for CY 2004 YTD. Waste types shown are representative and are not inclusive. (In many instances, individual buildings would qualify as conditionally exempt small-quantity generators. Listed wastes include only recurrent waste streams and not those from one-time activities such as remediation, asbestos abatement, demolition, etc.) Stormwater aspects from Ames Environmental Handbook, site-specific best management practices. Medical waste impacts from Environmental Handbook, Chapter 6, Appendix D. UST data from current permits; AST data from Ames SPCC/FRP. Radiation sources from Radiation Safety Office. (Listing includes only Class 3 and 4 lasers, non-exempt sealed sources, and x-ray generating sources.) Other aspects including PCBs, noise and vibration, and energy efficiency/pollution prevention not revised.					

2.14. NASA AMES RESEARCH PARK AND EASTSIDE AIRFIELD OPERATIONS

2.14.1. FACILITY USAGE

ARC contains many specialized and unique facilities that support the mission of ARC and the missions of the Resident Agencies. Resident Agency organizations use dedicated facilities for specified periods of time, ranging from a few days to years. Presently, there are more than a dozen different resident agencies using ARC facilities.

2.14.2. RESIDENT AGENCIES

Under NASA's oversight, the family of Resident Agencies, Research Partners, and tenants at ARC has grown considerably. The different organizations using a variety of facilities include:

- Onizuka Air Station, 21st Space Operations Squadron (21 SOPS)
- Army 63rd Regional Support Command (RSC)
- California Air National Guard (129th Rescue Wing)
- Defense Energy Supply Center
- Naval Facilities Southwest Division
- 787th Ordnance Company
- 7th Psychological Operations (PSYOP) Group
- Navy Exchange
- Defense Commissary
- Federal Bureau of Alcohol, Tobacco, and Firearms
- Federal Emergency Management Agency
- U.S. Postal Service

2.14.3. AIRFIELD OPERATIONS

The airfield at ARC is a fully functional federal airport with all the necessary facilities needed for aircraft operations. Aircraft facilities include:

- Two parallel runways, 2,804 meters (9,200 feet) and 2,469 meters (8,100 feet) long
- Three large hangars, approximately 305 by 91 meters (1,000 by 300 feet)
- Aircraft wash facilities

- Aircraft fuel terminal facility
- 24-hour crash, fire, and rescue
- 16-hour air traffic control tower
- More than 70 structures related to airfield operations
- Extensive ramp space
- Instrument landing system
- Pilot weather briefings
- Flight planning service

Hangar 1 is a contributing element in the Shenandoah Plaza Historic District. It is one of the largest hangars in the world, and until recently housed hangar, administrative, warehouse, maintenance, and classroom space. Hangar 1 is one of the buildings contributing to the historic Shenandoah Plaza District. Hangar 1 was designated as the future home of Spaceworld Hangar 1, a planned nonprofit educational complex. However, the schedule for this use is uncertain pending solution of the PCB problems at Hangar 1 (see discussion in Section 2.11.1).

2.14.4. MILITARY FACILITIES

Military facilities include the California Air National Guard and US Army Reserve facilities at the Center.

2.14.5. MULTIPURPOSE FACILITIES

ARC has a wide range of facilities suitable for administration activities, aircraft and vehicle maintenance, warehouse space, and living quarters. With varying degrees of alterations, these facilities can be tailored for many different uses. Almost 400,000 square meters (4.3 million square feet) of space are available, including:

- Storage/hangar space/maintenance/shops, 135,856 square meters (1,462,344 square feet)
- Office space, 246,886 square meters (2,657,464 square feet)

The NASA Ames Development Plan includes planning for more office space and additional housing.

2.14.6. AMENITIES INFRASTRUCTURE

Other facilities and infrastructure that support the quality of life at NASA include:

- Bike/hiking trail access
- U.S. Post Office

- Golden Bay Federal Credit Union
- Cafeteria/McDonalds/deli
- Moffett Training and Conference Center
- Base police/security force
- World-class communication infrastructure
- Satellite and fiber optic links
- Recreation and fitness facilities

2.15. SIGNIFICANT ASPECTS AND ENVIRONMENTAL IMPACTS OF NASA AMES RESEARCH CENTER OPERATIONS

Table 2-4 contains a listing of the significant aspects and environmental impacts resulting from Ames Research Center Operations.

Table 2-4 Significant Aspects Summary for NASA Ames Research Center

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
N-200	1943 2461 square meters (26,485 square feet)			Hazardous Materials	Flammable liquids, corrosives, other regulated materials
N-202 CODE DK - Commercial Technology Office CODE DXC - Communication Branch	1950 2,470 square meters (26,508 square feet)	Space Technology	Physical sciences laboratory: sensor development, intelligent systems, thermal protection systems, life support technology	Hazardous Materials	Corrosives
N-203 CODE SG - Earth Science Division CODE JIT - Documentation Technology Division CODE CF - Financial Management Division	1942 2,144 square meters (23,080 square feet)	Imaging Technology Laboratory	Photo-development	Hazardous Materials	Oxidizers/peroxides, corrosives, poisons, other regulated materials
				Hazardous Waste	Batteries
				Pollution Prevention	Beneficial: Photolaboratory treatment systems reduce hazardous waste and industrial wastewater

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
N-204 and N-204A CODE ASF – Thermo-Physics Facilities	1955 1374 square meters (14,782 square feet) 587 square meters (6,314 square feet)	Vertical Gun Range	Photo-development	Air Pollution	POCs (wipe cleaning)
				Hazardous Materials	Explosives, gasses, flammable liquids, poisons
				Radiation Sources	Class 4 laser
				Hazardous Waste	Paints
N-206 and N-206A CODE FOF - Aeronautical Facilities Engineering Branch CODE FOW - Wind Tunnel Operations Branch	1946 and 1969 4,966 square meters (53,436 square feet) 1,092 square meters (11,751 square feet)	12-Foot Pressure Wind Tunnel	Low-turbulence testing	Air Pollution	Coatings usage (VOCs), POCs (wipe cleaning)
				Industrial Wastewater	Wind tunnel cooling tower blowdown
				Hazardous Materials	Gasses, flammable liquids, corrosives, other regulated materials
				PCBs	Transformer (> 500 ppm)
				Storage Tanks	8 ASTs (hydraulic oil, 60-850 gal.)
				Pollution Prevention	Beneficial: CFC Replacement, Minimization of hazardous waste
				Energy Efficiency	Beneficial
				Noise and Vibration	Occupational Noise
			Radiography	Recycling	Beneficial: Silver recycling

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
N-207	1946 2,531 square meters (27,239 square feet)			Air Pollution	Coatings usage (VOCs), POCs (wipe cleaning)
N-207A CODE FOF - Aeronautical Facilities Engineering Branch	1949 723 square meters (7,778 square feet)	Balance Calibration Laboratory	Physical Sciences Laboratory	Hazardous Materials	Gases, flammable liquids, corrosives, other regulated materials
				Hazardous Waste	Solvents, adhesives/catalysts
				PCBs	Transformer (< 50 ppm)
N-210 CODE AR - Army/NASA Rotorcraft Division	1947 7,746 square meters (83,350 square feet.	Flight Systems Research Laboratory	Physical Sciences Laboratory	Air Pollution	POCs (wipe cleaning)
				Hazardous Materials	Corrosives, flammable liquids, other regulated materials
				Industrial Wastewater	HVAC blowdown
				Hazardous Wastes	Batteries
				PCBs	Three transformers (>500 ppm)
N-211	1945 17.849 square meters (192,056			Air Pollution	VOCs (spray painting), POCs (wipe cleaning), POCs (wipe cleaning)
				Hazardous Waste	Non-halogenated oil, oil filters, contaminated solids; batteries; cleaners; fuel filters

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
	square feet)			Storage Tanks	3 ASTs (diesel, 50 gal.; JP-8, 5,000 and 19,500 gal.)
N-212 CODE JMC –	1950 1,478 square meters (15,906 square feet)	Model Development	Model Shop	Air Pollution	Coatings usage (VOCs), POCs (wipe cleaning)
				Hazardous Materials	Gases, flammable liquids, corrosives, poisons, other regulated materials
				Hazardous Wastes	Paints, paint thinner, and paint-contaminated solids and rags; batteries; adhesives; aerosol cans
				Pollution Prevention	Source reduction of paint booth debris (paint sprayer and liquid management system)
N-213	1950 9,351 square meters (100,622 square feet)			Hazardous Materials	Flammable liquids, corrosives, poisons, other regulated materials
				Radiation Sources	Class 4 lasers
				Storage Tanks	1 AST (diesel, 350 gal.)
				Hazardous waste	Batteries; misc. laboratory reagents and chemicals
				Air Pollution	POCs (wipe cleaning)

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
N-214	1942 261 square meters (2,804 square feet)			Hazardous Materials	Flammable liquids, corrosives, poisons, oxidizer/peroxide, other regulated materials
				Industrial Wastewater	Compressor cooling water
N-215	1941 1,607 square metes (17,295 square feet)			Air Pollution	Solvent usage, POCs (wipe cleaning)
				Hazardous Waste	Medical waste, batteries
				Hazardous Materials	Flammable liquids, gases, corrosives, poisons, other regulated materials
				Storage Tanks	1 AST (diesel, 175 gal.)
N-216 and N-216A-B	1941 and 1973 520 square meters (5,598 square feet) 484 square meters (5,203 square feet) 457 square meters (4,917 square feet)			Air Pollution	Solvent usage, POCs (wipe cleaning)
				Industrial Wastewater	Laser cooling water
				Radiation Sources	Class 3 and 4 lasers
				Hazardous Wastes	Solvents, oily rags
				Hazardous Materials	Flammable liquids, corrosives, poisons, gases, other regulated materials
				PCB Management	Transformer (<50 ppm PCBs)
				Pollution Prevention	Motor coolant water recycling

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
N-217 and N-217A CODE J - Center Operations CODE JF - Facilities, Logistics and Airfield Management	1969 and 1972 78 square meters (844 square feet) 263 square meters (2,829 square feet)	Magnetic Standards Laboratory and Test Facility	Calibrate magnetic sensors, magnetize and demagnetize instruments, simulate magnetic field	PCBs	Transformer (<50 ppm PCBs)
				Pollution Prevention	Coolant Recovery System (recycles used machine coolant – 3,000 gallons/year)
N-218	1941 2,926 square meters (31,488 square feet)			Hazardous Materials	Flammable liquids, poisons, corrosives, other regulated materials, medical waste
				Radiation Sources	Sealed sources (Ra-226, Cs-137, Am-241, Fe-55, Cd-109, Ni-63)
				Storage Tanks	1AST (oil, 2,000 gal., inactive)
				Hazardous Waste	Batteries, solvents, oil
				Air Pollution	Coatings usage (VOCs), POCs (wipe cleaning)
N-220 CODE FMX -	1940 3,729 square	Technical Services	Development machining and electromechanica	Air Pollution	Solvent usage (permitted equipment), coatings usage (VOCs), parts cleaner, POCs (wipe cleaning)

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
Development Machining and Electromechanical Instrumentation Branch	meters (40,122 square feet)		l instrumentation; develops prototype hardware	Hazardous Materials	Gases, flammable liquids, corrosives, poisons, other regulated materials
				Hazardous Waste	Batteries, oil-contaminated water and rags, inorganic compounds, contaminated solids, solvents and adhesives
				PCBs	Three transformers (Tag #154->500 ppm PCBs, all others <50 ppm PCBs)
				Noise and Vibration	Community and occupational noise
				Pollution Prevention	Waste-minimization reusable steel grit to remove lead-based paint; milling machine cooling water recycling
				Recycling	Acoustic foam
N-221 and N-221B CODE DQH - CODE FOI - Wind Tunnel Systems Branch CODE FOF - Aeronautical Facilities Engineering Branch	1944 and 1985 14,992 square meters (161,312 square feet) 1,932 square meters (20,783	40- by 80-Foot Wind Tunnel and 80-by 120-Foot Wind Tunnel	Low-speed testing and configuration validation	Hazardous Materials	Gasses, corrosives, flammable liquids, oxidizers, poisons, other regulated materials
				Air Pollution	NOx, combustion products (engine testing), coatings usage (VOCs), POCs (wipe cleaning)
				Radiation Sources	Class 4 laser
				Storage Tanks	5 ASTs (hydraulic oil, 350 – 3,000 gal), 1 AST (jet fuel, 500 gal.)
				Hazardous Wastes	Mercury-containing wastes, fluorescent tubes, batteries, paints, oily water

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
CODE FOW - Wind Tunnel Operations Branch	square feet)			Industrial Wastewater	Chiller condensate
N-221A CODE SLE - Payloads and Facilities Engineering Branch	1964 602 square meters (6,474 square feet)	20-G Centrifuge	Centrifuge	PCBs	28 transformers (Tag # 6 52 ppm PCBs, Tag #4 54 ppm PCBs, Tag #24 201 ppm PCBs, Tag #32 55 ppm PCBs, all others <50 ppm PCBs)
				Noise and Vibration	Occupational Noise
N-223 CODE ASM - Aerosol Laboratory Code ASN – Plasma Laboratory	1955 2218 square meters (23, 870 square feet)			Air Pollution	POCs (wipe cleaning)
				Hazardous Materials	Corrosives, flammable liquids/solids, gasses, poisons, oxidizers, other regulated materials
				Storage Tanks	1 AST (diesel, 85 gal.)
				Stormwater	Display aircraft washing (oils/grease, heavy metals)
				Hazardous Wastes	Contaminated solids, solvents, corrosives, batteries, mercury-containing wastes, ethylene glycol, organics
N-225B	1975 (Substation)			Storage Tanks	1 AST (oil, 1,000 gal.)
N-226	1964 3,144 square			Hazardous Materials	Gasses, flammable liquids, oxidizer/peroxides

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
	meters (33,832 square feet)				
N-227, N227A-D CODE FOF - Aeronautical Facilities Engineering Branch CODE FOW - Wind Tunnel Operations Branch	1955 5,440 square meters (58, 537 square feet) 1,750 square meters (18,825 square feet) 1,931 square meters (20, 774 square feet) 1,341 square meters (14,430 square feet) 917 square meters (9,871	Unitary Plan Wind Tunnel	Aerodynamics testing	Hazardous Materials	Gases, flammable liquids, and corrosives, oxidizer/peroxide, poisons, other regulated materials
				Air Pollution	Coatings usage (VOCs), POCs (wipe cleaning)
				Radiation Sources	Class 4 laser
				Storage Tanks	14 ASTs (hydraulic and DTE oil, diesel, 80- 8,000 gal.)
				Hazardous Wastes	Batteries; non-halogenated oil, oil filters, oily rags, and oily water; kerosene; paints and solvents; contaminated solids; fluorescent tubes
				Industrial Wastewater	Wind tunnel cooling tower blowdown

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
	square feet)			Conservation	Historical buildings
N-229 CODE ASF - Thermo-Physics Facilities Branch	1961 3,150 square meters (33,890 square feet)	Electric Arc Shock Tube	Physical Sciences Laboratory	Air Pollution	POCs (wipe cleaning)
				Hazardous Materials	Gases, corrosives, flammable liquids, other regulated materials
				Hazardous Wastes	Batteries, contaminated solids, organic compounds
				PCBs	Five Transformers (Rm. 156, Shop >500 ppm PCBs, all others <50 ppm PCBs)
				Radiation Sources	Class 4 laser
N-229A-B CODE FOF Aeronautical Facilities Engineering Branch CODE ASF - Thermo-Physics Facilities Branch	1976 and 1978 2,249 square meters (24,200 square feet) 460 square meters (4,947 square feet)	3.5-Foot Hypersonic Wind Tunnel	Wind Tunnel Testing	Air Pollution	Coatings usage (VOCs), parts cleaner, POCs (wipe cleaning)
				Hazardous Wastes	Laboratory chemicals
				Storage Tanks	4 ASTs (300 – 4,000 gal., Fryqual, waste oil, waste oil/water)
N-230	1960	Physical Sciences	Photophysics, materials	Hazardous Materials	Gasses, flammable liquids, poisons, corrosives, other regulated materials

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
CODE ASC - Computational Chemistry Branch CODE ASA - Reacting Flow Environments Branch	3,034 square meters (32,650 square feet)	Research Laboratory	research	Air Pollution	POCs (wipe cleaning)
				Hazardous Waste	Solvents
				Radiation Sources	Class 3B, 4 lasers
				Storage Tanks	6 ASTs (oil, 100 gal.)
N-231 CODE ASF -	1960 717 square meters (7,718 square feet)			Air Pollution	Solvent usage, POCs (wipe cleaning)
				Hazardous Materials	Flammable liquids, gasses, other regulated materials
N-233 and N-233A CODE JT - Applied Information Technology Division	1960 and 1973 5,636 square meters (60,642 square feet) 3,055 square meters (32,872 square feet)	Central Computer Facility	Advanced computer technology and systems	Hazardous Waste	Inorganic liquids, toner
				Hazardous Materials	Flammable liquids, corrosives, oxidizer/peroxide, other regulated material
				PCBs	Transformer (<50 ppm PCBs)
				Pollution Prevention	Beneficial: Onsite treatment of hazardous waste
				Recycling	Ames Chemical Exchange

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
N-234 CODE ASF - Thermo-Physics Facilities Branch CODE ASM – Materials Characterization Lab	1962 2,489 square meters (26,781 square feet)	Thermal Protection Laboratory	High-enthalpy materials research; includes Aerodynamic Heating Facility and Turbulent Flow Duct Facility	Air Pollution	Coatings usage (VOCs), POCs (wipe cleaning)
				Hazardous Materials	Flammable liquids/solids, poisons, corrosives, gasses, oxidizer/peroxide, other regulated materials
				Radiation Sources	Class 3B, 4 lasers, X-ray diffraction machine (60 kV), electron microscope (25 kV)
				Hazardous Wastes	Batteries, organic compounds, solvents and cleaners
				Storage Tanks	1 AST (hydraulic oil, 100 gal.)
				Water Conservation	X-ray machine cooling water recycling
N-234A CODE ASF - Thermo-Physics Facilities Branch CODE FOF - Aeronautical Facilities Engineering Branch	1962 281 square meters (3,019 square feet)	Thermal Protection Laboratory Boiler	Boiler	Industrial Wastewater	Boiler scrubber, plenum spray maintenance
				Hazardous Materials	Gases, flammable liquids/solids, oxidizers/peroxides, poisons, corrosives, other regulated materials
				Hazardous Waste	Cooling tower sludge, used containers, barium compounds, organic compounds
				Air Pollution	NOx, combustion products (boiler for arc jet)
N-235	1964 1,152 square meters (12,400 square feet)			Hazardous Materials	Gasses, corrosives, other regulated materials
				Industrial Wastewater	Kitchen usages

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
N-236 CODE SLO - Science Payloads Operations Division CODE SLE - Payloads and Facilities Engineering Branch	1964 1,852 square meters (19,929 square feet)	Biosciences Laboratory	Biomedical research and animal care	Industrial Wastewater	Animal facility and cage cleaning
		Animal Research Incinerator	Incinerator	Air Pollution	Pathological waste incineration (permitted equipment)
				Hazardous Materials	Gases, flammable liquids/solids, corrosives, poisons, oxidizer/peroxide, other regulated materials
				Hazardous Waste	Medical/pathological waste, solvents, photo developer/fixer, organic compounds, contaminated solids, used containers
				Radiation Sources	Radiographic machines (76 kV, 150 kV)
				PCBs	PCB capacitors and solids
				Storage Tanks	2 ASTs (diesel, 80-120 gal.)
N-237	1964	Hypervelocit	Aeroballistic	Air Pollution	POCs (wipe cleaning)

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
CODE AP - Aeronautical Projects and Programs Office CODE ASF - Thermo-Physics Facilities Branch CODE APM - Advanced Aircraft and Powered Lift Branch	5,601 square meters (60,271 square feet)	y Free-Flight Facility	range and large-scale Combustion Driven Shock Tunnel	Industrial Wastewater	HVAC blowdown
				Hazardous Waste	Batteries
				Hazardous Materials	Gasses, flammable liquids, corrosives, poisons, explosives, other regulated materials
				PCB Management	Four transformers (<50 ppm PCBs)
				Radiation Sources	Class 4 lasers
				Pollution Prevention	Elimination of copper from treatment chemicals, oil/water separator
				Noise and Vibration	Occupational noise
N-238 CODE ASF - Thermo Physics Facilities Branch	1964 1,638 square meters (17,629 square feet)	Arc Jet Complex	High enthalpy materials research; includes Panel Test Facility and Interaction Heating Facility	Air Pollution	NO_x, combustion products (arc jet heating), coatings usage (VOCs), POCs (wipe cleaning)
				Hazardous Materials	Gasses, flammable liquids, poisons, corrosive, other regulated materials
				Hazardous Waste	Batteries, solvents and thinners, contaminated solids, oil and oily rags
			Laser Seeding	Radiation Sources	Class 3b, 4 lasers
N-239 and N-239A	1965 and 1966	Life Sciences Research	Human-machine biomedical and	Air Pollution	POCs (wipe cleaning)

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
CODE SLR - Gravitational Research Branch CODE SSX - Exobiology Branch CODE SL - Life Sciences Division CODE SSR - Astrobiology Technology Branch CODE SLE - Payloads and Facilities Engineering Branch Code AMS - Nanotechnology	12,026 square meters (129,400 square feet) 2,801 square meters (30,136 square feet)	Laboratories	extraterrestrial research, ecosystem science, closed ecological life support systems	Industrial Wastewater	HVAC blowdown, laboratory glassware washing machine, laboratory sinks
				Hazardous Materials	Gases, flammable liquids/solids, poisons, corrosives, oxidizer/peroxide, other regulated materials
				Hazardous Waste	Medical/pathological waste, batteries, organic and contaminated solids, organic liquids and solvents, inorganic acids, adhesives and misc. laboratory chemicals, non-halogenated oil and oily wastes, mercury-containing wastes, used containers, mercuric chloride
				Radiation Sources	Class 4 laser, sealed sources (Ni-63, H-3), electron microscopes (30 kV, 60 kV, 80 kV, 200 kV)
				PCBs	Transformer (< 50 ppm PCBs)
				Storage Tanks	2 ASTs (diesel, 500 gal.)
N-240 and N-240A CODE SLO - Science Payloads Operations Branch CODE SG - Earth Science Division	1965 and 1982 4,753 square meters (51,140 sq. ft.) 1,156 square	Airborne Missions and Applications Laboratory	Research in life-sciences payload; Wet chemistry laboratory	Air Pollution	Ethylene oxide (sterilizer), POCs (wipe cleaning)
				Industrial Wastewater	HVAC blowdown
				Hazardous Materials	Gasses, flammable liquids/solids, poisons, corrosives, oxidizers, other regulated materials
				Radiation Sources	Electron microscope (20kV)

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
	meters (12,443 square feet)			Hazardous Waste	Batteries, paints and resins, ethylene glycol
N-241	1965 5,936 square meters (63,870 square feet)			Hazardous Materials	Flammable liquids, corrosives
				Storage Tanks	1 AST (diesel, 250 gal.)
				Hazardous Wastes	Oily water, contaminated solids, paints, batteries, lead-containing debris
				Industrial Wastewater	HVAC blowdown
N-242 CODE SGE - Ecosystem Science and Technology Branch Code ASF – Mars Unit Code ASM – Coatings Lab	1966 2,985 square meters (32,120 sq. ft.)	Vestibular Research	Ground-based studies of vestibular function;	Air Pollution	Solvent usage, POCs (wipe cleaning)
				Hazardous Materials	Gasses, flammable liquids/solids, corrosives, oxidizers, poisons, other regulated materials
				Hazardous Waste	Contaminated solids, batteries, used containers
				PCBs	Four Transformers (Tag # 104->500 ppm PCBs, Tag #100- 68 ppm PCBs, Tag #99 - 99 ppm PCBs, Tag #102 - 52 ppm PCBs)
				Pollution Prevention	Source Reduction of Paint Booth Debris (includes High Volume Low Pressure paint sprayer and Liquid Management System), 3 Air Compressor Oil/Water Separators
				Radiation Sources	Class 3b laser
N-243 and N-243A	1967	Flight and Guidance	Flight safety, aeronautical	Air Pollution	VOCs (spray painting), parts cleaner, POCs (wipe cleaning)

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
CODE ASF - Simulation Projects and Systems Branch CODE AF - Aviation Systems Research, Technology and Simulation Division	58,701 square meters (631,623 sq. ft.) 883 square meters (9,503 square feet)	Simulation Laboratory	handling qualities and flight dynamics	Industrial Wastewater	HVAC blowdown
				Hazardous Materials	Gasses, flammable liquids, oxidizers/peroxides, poisons, corrosives, other regulated materials
				Storage Tanks	1 AST (hydraulic oil, 800 gal.)
				Hazardous Waste	Batteries, paints, oily water and rags
N-244 CODE SF - Space Projects Division CODE SFE - Project Operations Branch CODE JEE -	1967 7,816 square meters (84,100 sq. ft.)	Space Projects Facility	Offices and laboratories for developing and managing space projects; computer systems, environmental test laboratory	Air Pollution	Coatings usage (VOCs), POCs (wipe cleaning)
				Industrial Wastewater	HVAC blowdown
				Hazardous Materials	Gasses, flammable liquids, poisons, corrosives, other regulated materials
				Hazardous Waste	Batteries, adhesives and solvents, oils
				PCBs	2 Transformers (<50 ppm PCBs)
				Radiation Sources	Class 3b lasers, sealed sources (Ra-226)
N-245 CODE JIL - Research Information Resources Branch CODE SSA -	1970 7,500 square meters (80,705 sq. ft.)	Space Sciences Research Laboratory	Research in planetary atmospheres, planetary evolution, astrophysics, infrared	Air Pollution	POCs (wipe cleaning)
				Hazardous Wastes	Batteries, methanol, ethylene glycol, inorganic acids, compressed gasses and cylinders, oil, contaminated solids
				Hazardous Materials	Gases, flammable liquids/solids, corrosives, oxides/peroxide, poisons, other regulated materials

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
Astrophysics Branch			astronomy, earth science and planetary geology	Storage Tanks	1 AST (diesel, 110 gal.)
				Radiation Sources	Sealed sources (Ni-63)
				Industrial Wastewater	HVAC blowdown
				Noise and Vibration	Occupational Noise
N-246	1973 3,462 square meters (37,252 square feet)			Hazardous Materials	Gasses, flammable liquids, poisons, other regulated materials
				Air Pollution	Coatings usage (VOCs), POCs (wipe cleaning)
				Hazardous Wastes	Oil, batteries
				Industrial Wastewater	Model prep. cooling water
N-247	1975 1,002 square meters (10,777 square feet)			Air Pollution	NOx, combustion products (engine testing)
				Hazardous Wastes	Batteries
N-248 and N-248A-E CODE ARM- Space Projects Division	1973, 1973, 1976, 1987, and 1995 3,198 square meters (34,412 square feet)			Air Pollution	Organic vapor (washrack oil/water separator), coatings usage (VOCs), POCs (wipe cleaning)
				Industrial Wastewater	Aircraft washrack
				Hazardous Materials	Gasses, flammable liquids, other regulated materials
				Stormwater	Petroleum hydrocarbons, oil and grease

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
	386 square meters (4,148 square feet) 285 square meters (3,068 square feet) 533 square meters (5,738 square feet) 283 square meters (3,048 square feet) (N248E – washrack)			Pollution Prevention	Replace trichloroethylene use with aqueous cleaner
				Hazardous Waste	Batteries, oily water, JP-8, contaminated solids, non-halogenated oils, used containers, misc. paints and solvents, grease and lubricants, alodine, aerosol cans, misc. chemicals
N-249 CODE FOF - Aeronautical Facilities Engineering Branch	1975 308 square meters (3,314 sq. ft.)	Outdoor Aerodynamic Research Facility	Vertical take-off and landing	Air Pollution	POCs (wipe cleaning)
				Stormwater	Aircraft maintenance (oils, petroleum products, heavy metals)
				Energy Efficiency	Vehicle/Engine care
N-250 CODE AFS-	1974 248 square meters (2,671 square feet)	High-Pressure Facility		Hazardous Materials	Gasses, corrosives, flammable liquids
				Storage Tanks	1 AST (oily water, 4,000 gal.)

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
N-251	1977 367 square meters (3,945 square feet)			Hazardous Materials	Gasses, flammable liquids, other regulated materials
				Air Pollution	Fuel dispensing (VOC emissions), parts cleaner, POCs (wipe cleaning)
				Storage Tanks	2 USTs (4,000 gal., gasoline; 2,500 gal., diesel); 3 ASTs (65 gal., misc. oils and lubricants); 4 ASTs (500 – 2,000 gasoline and diesel fuel, inactive)
				Stormwater	Runoff from fleet parking (oil and grease, antifreeze, fuel); vehicle fueling; vehicle maintenance and wash rack (oil and grease, fuel, heavy metals, etc.)
				Hazardous Wastes	Diesel fuel, ethylene glycol, non-halogenated oil and oil filters, aerosol cans, used containers, oily waters and rags, gasoline, sump water, contaminated solids
				Industrial Wastewater	Vehicle wash rack
N-254	1980 555 square meters (5,967 square feet)			Hazardous Materials	Flammable liquids, corrosives, poisons
				Storage Tanks	1 AST (diesel, 800 gal.)

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
N-255	1978 7,587 square meters (81,639 square feet)			Hazardous Materials	Gasses, flammable liquids, corrosives, poisons, other regulated materials
				Stormwater	Runoff from fleet vehicle parking (oil and grease, antifreeze, fuel)
				Hazardous Wastes	Toner, misc. chemicals
				Air Pollution	Particulates (shredder, permitted equipment)
N-257 CODE AFS - Simulation Projects and Systems Branch	1982 1,630 square meters (17,535 sq. ft.)	Crew Vehicle Systems Research Facility	Human Performance Research/Computational Research	Hazardous Waste	Batteries, contaminated solids, oily rags
				Storage Tanks	2 ASTs (hydraulic oil, 220 – 400 gal.)
				Hazardous Materials	Gasses, flammable liquids/solids, poisons, other regulated materials
				Air Pollution	Coatings usage (VOCs), POCs (wipe cleaning)
N-258 CODE IN - Numerical Aerospace Simulation (NAS) Systems Division Code APS	1986 8,846 square meters (95,188 sq. ft.)	Numerical Aerodynamic Simulation Facility	Computational Research Cooling Tower	Hazardous Materials	Gasses, flammable liquids, corrosives and other regulated materials
				Hazardous Waste	Batteries, fluorescent tubes
				Storage Tanks	1 AST (diesel, 110 gal.)
N-259	1984			Hazardous Materials	Gasses, flammable liquids, poisons, other regulated materials

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
	557 square meters (5,988 square feet)			Air Pollution	Coatings usage (VOCs), POCs (wipe cleaning)
N-260 CODE APS - Experimental Physics Branch	1987 2,548 square meters (27,419 sq. ft.)	Fluid Mechanics Laboratory	Computational Fluid Dynamics	Hazardous Materials	Flammable liquids, other regulated materials
				Hazardous Waste	Organic compounds, paints and solvents, aerosol cans, non-halogenated oils, oily rags, batteries
				Air Pollution	Coatings usage (VOCs), POCs (wipe cleaning)
				Storage Tanks	1 AST (hydraulic oil, 150 gal.)
				Radiation Sources	Class 4 lasers
N-261 CODE SLO - Science Payloads Operations Branch	1989 1,539 square meters (16,560 sq. ft.)	Biomedical Research Facility	Neurosciences research	Hazardous Materials	Gasses, corrosives, other regulated materials
				Hazardous Waste	Organic liquids and solids, contaminated solids, used containers, solvents, batteries
N-262 CODE AFS - Human Factors Research and Technology Division	1990 6,846 square meters (73,658 sq. ft.)	Human Performance Research Facility	Research on advanced aeronautical and space systems	Air Pollution	POCs (wipe cleaning)
				Hazardous Waste	Batteries, solvents
				Hazardous Materials	Corrosives, flammable liquids/solids
N-263	1989			Hazardous Materials	Flammable liquids, corrosives

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
	236 square meters (2,543 square feet)			Storage Tanks	1 AST (diesel, 300 gal.)
N-265 CODE QE - Environmental Services	1988 431 square meters (4,638 square feet)	Hazardous Substances Transfer Site	Package Hazardous Wastes	Hazardous Materials	Gasses, flammable liquids/solids, oxidizers, poisons, other regulated materials
				Hazardous Waste	(Note: this location is a waste consolidator rather than a waste generator.)
				Storage Tanks	3 ASTs (oily water, 100 – 1,200 gal.)
N-267	1991 592 square meters (6,367 square feet)			Hazardous Materials	Gasses, flammable liquids, corrosives, oxidizer/peroxide, other regulated materials
				Radiation Sources	Sealed source (Ni-63)
				Stormwater	Runoff from fleet vehicle parking (oil and grease, antifreeze, fuel)
				Air Pollution	Particulates, combustion products (tub grinder and brush chipper and engines)
N-269 CODE IC - Computational Sciences Division	1990 5,645 square meters (57,643 sq. ft.)	Automation Sciences	Human/machine interactions; mapping (visual), acoustic and sensing	Radiation Sources	Class 3b lasers
				Hazardous Waste	Batteries, contaminated solids, resins, adhesives, solvents

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
			information systems	Hazardous Materials	Flammable liquids, corrosives, other regulated materials
N-271	1999 (Pre-treatment plant)		Wastewater treatment plant	Hazardous Materials	Corrosives, other
				Hazardous Waste	Contaminated solids
				Industrial discharge	Pretreatment facility discharge to municipal sewer (29,510 gpd)
1, 46, 47 CODE JF - Facilities, Logistics and Airfield Management Division	Hangar 1: 1933 35,795 square meters (385,290 sq. ft.) Hangar 2 and 3: 1942 32,226 square meters (346,875 sq. ft.) and 40,296 square meters (433,738 sq. ft.)	Hangars 1,2 and 3	Aircraft Maintenance, Storage and Defueling	Stormwater	Hazardous Materials/Waste Usage and Storage: Petroleum hydrocarbons, Oil and Grease
				Air Pollution	Organic vapor (aircraft wash oil/water separator)
				Hazardous Waste	Waste oil, oil filters, oil rags, oil-contaminated solids and water; batteries; contaminated fuel; paints, adhesives, and organic compounds; aerosol cans
				Storage Tanks	AST (50 gal. diesel, Bldg. 47)
				Historical Resources	Conserved: Shenandoah Plaza Historic District
ARC--All Facilities Center-wide	266,880 covered square meters			Air Pollution	Solvent wipe cleaning, architectural coatings, NOx and combustion products (boilers, emergency and mobile generators)

Facility Number and Program	Date of Construction and Square Feet*	Facility Name	Use	Aspects	Significant Aspects
Land	(2,800,000 square feet) 448 acres			Hazardous and Solid Wastes (RCRA and non-RCRA)	Debris and remediation waste (soil), used oil and oily water, PCB-containing wastes, jet fuel, laboratory and shop wastes (satellite and 90-day accumulation areas), universal wastes, solid (sanitary) waste
				Water Consumption	235,000 gpd (includes sanitary, industrial, cooling, and irrigation uses)
				Industrial/Sanitary Discharge	115,000 gpd
				Energy Consumption	27,700kWh/year
				Conservation/ Restoration	Vegetation, wetlands, fish, and wildlife preservation; historical resource preservation; groundwater and soil restoration
				Hazardous Materials	Sundry chemicals/usages (HMIS site inventory) not elsewhere listed

*Total Gross Floor Area primarily from Facilities' *Building Layouts* and from NASA *Property Listing Report* if data not available in *Building Layouts*. Date Construction Completed and Land areas from AMES Research Center/Moffett Federal Airfield *Property Listing Report.* Hazardous materials impacts from 4D-*Hazardous Material Permits*. Air impacts from 4-D *Air Permits*. Industrial wastewater discharges from Sunnyvale and Palo Alto permit application data. Only individual discharges in excess of 100 gpd (including both continuous and intermittent discharges/discharge potential) are identified. Hazardous wastes based on *Biennial Report* and *Form A* data for CY 2004 YTD. Waste types shown are representative and are not inclusive. (In many instances, individual buildings would qualify as conditionally exempt small-quantity generators. Listed wastes include only recurrent waste streams and not those from one-time activities such as remediation, asbestos abatement, demolition, etc.) Stormwater aspects from Ames *Environmental Handbook*, site-specific best management practices. Medical waste impacts from *Environmental Handbook*

Chapter 3. Socioeconomics

3.1. OVERVIEW

This chapter describes existing socioeconomic conditions in and around ARC. Information regarding population and employment at the regional, county, and local levels, the local housing market and fiscal conditions of the county, local jurisdictions, school districts, and ARC are analyzed. Information provided in Sections 3.3 (Regional Setting) and 3.4 (Existing Conditions), was obtained from the NASA Ames Development Plan Final Programmatic Environmental Impact Statement (Design, Community & Environment 2002) and the October 2003 Draft Environmental Resources Document (NASA 2003), unless otherwise indicated.

Although portions of ARC lie within the boundaries of the cities of Sunnyvale and Mountain View, it is primarily located in unincorporated Santa Clara County (County). The 2000 Census recorded 1,682,585 residents residing in the County, making it the most populous county in the San Francisco Bay Area (Bay Area) (Association of Bay Area Governments 2000). San Jose is the largest and fastest growing city in the county with a population of 894,943, according to the 2000 Census.

The Association of Bay Area Governments (ABAG) is a regional planning agency that oversees nine Bay Area counties, including the County. There are 6.7 million residents within the ABAG region, a population that was expected to grow to 7.7 million by 2005.

3.1.1. REGIONAL EMPLOYMENT

The County is recognized worldwide as a major center for high technology development, which includes many of the following firms:

- Adobe Systems, Inc.
- Apple Computer
- Applied Materials, Inc.
- Advanced Micro Devices
- Cisco Systems, Inc.
- Google
- Hewlett-Packard Company
- Intel Corporation
- IBM Almaden Research Group
- Lockheed-Martin Missiles and Space

- Motorola Computer Group
- Netscape Communications Corporation (acquired by AOL)
- Silicon Graphics, Inc.
- Sun Microsystems, Inc.

In August 2000, the County employed 999,600 people (State of California 2000), representing 25% of total employment in the Bay Area (ABAG 1997). The number of workers in the County was expected to increase by 19.1% by 2006 primarily among managers and professionals.

3.2. REGULATORY REQUIREMENTS

Social and economic impact assessment for environmental documents differs somewhat between the National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA). Under NEPA, an environmental impact statement (EIS) must consider social and economic effects if they are interrelated to natural or physical environmental effects, and its definition of effects includes social and economic factors (40 Code of Federal Regulations [CFR] 1508.8 and 1508.14). However, social and economic effects are not, by themselves, intended to require preparation of an EIS. Under CEQA, social and economic effects themselves are not considered environmental impacts; however, social and economic changes can be used to determine whether a physical change is significant, and social and economic effects can be discussed if they would result from a physical change and in turn lead to secondary physical changes (State CEQA Guidelines Section 15064[f]). CEQA does require the analysis of population and housing impacts, however. Because of these differences, more social and economic information is included in an EIS (or joint environmental impact report [EIR]/EIS) than in an EIR. (Bass and Herson 1993; Bass et al. 1999).

3.3. REGIONAL SETTING

3.3.1. POPULATION CHARACTERISTICS

This section describes regional, county, and local population characteristics. Based on the 2000 Census data, the cities of Mountain View and Sunnyvale had estimated population sizes of 72,200 and 131,760, respectively.

3.3.1.1. San Francisco Bay Area

The Bay Area has a population of 6,930,600, approximately one fifth of the state's population. The Bay Area includes the counties of Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma. Although Santa

Cruz is sometimes included as a 10th county, ARC adheres to a nine-county definition as set forth by ABAG.

Table 3-1 shows the population growth experienced in the Bay Area between 1990 and 2000, increasing at an average annual rate of 1.4% between 1990 and 2000. Santa Clara, Alameda, and Contra Costa counties are the largest counties and make up more than 57% of the Bay Area population and account for 43% of the growth. The Bay Area is expected to grow by approximately 13% over the next 15 years, to an expected population of 7.8 million.

Table 3-1 Population and Household Trends

	1990	2000 (est.)	Average Annual Change 1990-2000
Ames Research Center Area[1]			
Population[2]	184,689	212,000	1.4%
Households[2]	78,286	83,810	0.7%
Average Household Size[2]	2.35	2.51	0.7%
Employed Residents per Household[2]	1.47	1.54	0.5%
Household Type–Families[3]	57%	55%	-0.3%
Household Type–Non-Families[3]	43%	45%	0.4%
Tenure–Owner[4]	45%	NA	–
Tenure–Renter[4]	55%	NA	–
Santa Clara County			
Population	1,497,577	1,755,300	1.6%
Households	520,180	567,080	0.9%
Average Household Size	2.81	3.03	0.8%
Employed Residents per Household	1.56	1.64	0.5%
Household Type–Families	69%	67%	-0.3%
Household Type–Non-Families	31%	33%	0.6%
Tenure–Owner	59%	NA	–
Tenure–Renter	41%	NA	–
San Francisco Bay Area			
Population	6,020,147	6,930,600	1.4%
Households	2,245,865	2,438,060	0.8%
Average Household Size	2.61	2.78	0.6%
Employed Residents per Household	1.40	1.45	0.3%
Household Type–Families	65%	63%	-0.2%
Household Type–Non-Families	35%	37%	0.4%
Tenure–Owner	60%	NA	–
Tenure–Renter	40%	NA	–

[1] ARC area includes the combined jurisdictions of Mountain View and Sunnyvale. Population and Households are totals; all other figures are a-weighted average.
[2] Population, households, average household size, and employed residents per household data from ABAG Projections 2000.
[3] Household type data from Claritas, Inc.
[4] Tenure data from 1990 U.S. Census.
Source: Design, Community & Environment 2002

3.3.1.2. Santa Clara County

Between 1990 and 2000, the County population grew from 1.5 million to 1.8 million, an annual rate of 1.6%, primarily as a result of the high-technology industry in Silicon Valley. This increase accounts for 28.7% of growth in the Bay Area during this time. ABAG has projected an increase of 215,300 in the County between 2000 and 2015, an increase of 12.3%. Current population data and forecasts for the County are contained in Tables 3-1 and 3-2.

Table 3-2 Population and Household Projections

	2000	2005	2010	2015	Projected Change 2000–2015
Population					
Ames Research Center Area[1]	212,000	224,800	232,800	239,100	12.8%
Santa Clara County	1,755,300	1,854,000	1,919,000	1,970,600	12.3%
San Francisco Bay Area	6,930,600	7,380,100	7,631,400	7,832,600	13.0%
Households					
Ames Research Center Area[1]	83,810	87,420	90,640	93,890	12.0%
Santa Clara County	567,080	594,750	620,760	643,130	13.4%
San Francisco Bay Area	2,438,060	2,553,930	2,656,650	2,753,440	12.9%

[1] ARC area includes the combined jurisdictions of Mountain View and Sunnyvale.
Source: Design, Community & Environment 2002.

The number of households in the County is also increasing. In 1990, 59% of County households owned their home, an ownership rate lower than that of the total Bay Area, which is 60%.

Between 1990 and 2000, the County's mean household income grew by 19%, from $70,300 to $86,300 (in constant 1995 dollars) (see Table 3-3). The growth rate in the Bay Area was 16% during the same time period. County household income distribution is presented in Table 3-4.

Table 3-3 Mean Household Income Trends

	1990[1]	2000 (est.)	Change 1990–2000
Ames Research Center Area[2]	$63,191	$80,707	22%
Santa Clara County	$70,300	$86,300	19%
San Francisco Bay Area	$64,100	$76,400	16%

[1] All income amounts are expressed in inflation-adjusted 1995 dollars.
[2] ARC area includes the combined jurisdictions of Mountain View and Sunnyvale. Figure is the average of both cities' mean household income, adjusted for population.
Source: Design, Community & Environment 2002.

Table 3-4 Estimated 2000 Household Income Distribution

2000 Income	Ames Research Center Area[1]	Santa Clara County	San Francisco Bay Area
Less than $15,000	4.6%	6.2%	9.4%
$15,000 to $24,999	5.4%	6.0%	8.4%
$25,000 to $34,999	5.8%	6.2%	8.6%
$35,000 to $49,999	10.0%	10.3%	12.7%
$50,000 to $74,999	19.1%	19.2%	20.6%
$75,000 to $99,999	17.0%	16.3%	14.8%
$100,000 and above	38.2%	35.7%	25.6%
Median Income	$82,568	$78,057	$62,571

1 ARC area includes the combined jurisdictions of Mountain View and Sunnyvale.
Source: Design, Community & Environment 2002.

The median age in the County is 35.3 years, as compared to 36.9 for the Bay Area (see Table 3-5).

Table 3-5 Age Distribution 1990 and 2000

	1990	2000 (est.)
Ames Research Center Area[1]		
Under 18	18.8%	21.0%
18–24	10.4%	6.1%
25–34	25.9%	18.6%
35–44	16.1%	19.4%
45–54	10.3%	14.4%
55–64	8.2%	8.8%
65+	10.2%	11.7%
Median Age	33.0	37.2
Santa Clara County		
Under 18	24.2%	24.7%
18–24	11.6%	8.6%
25–34	21.1%	16.1%
35–44	16.2%	17.4%
45–54	10.8%	14.5%
55–64	7.5%	8.4%
65+	8.6%	10.2%
Median Age	31.7	35.3
San Francisco Bay Area		
Under 18	23.2%	23.9%
18–24	10.5%	8.0%
25–34	19.6%	14.8%
35–44	17.1%	18.0%
45–54	10.8%	14.8%
55–64	7.9%	8.8%
65+	11.0%	11.7%
Median Age	33.4	36.9

[1] ARC area includes the combined jurisdictions of Mountain View and Sunnyvale.
Source: Design, Community & Environment 2002.

3.3.1.3. Ames Research Center Area

The ARC area includes the cities of Sunnyvale and Mountain View, which surround the ARC. The ARC area has a population of 212,000, or approximately 12% of County residents. The ARC area experienced an annual population increase of 1.4% between 1990 and 2000, whereas the County experienced an annual growth rate of 1.6% during the same time period. ABAG projects a 12.8% population increase in this area over the next 15 years, adding 27,100 residents.

As of 1990, 45% of ARC area households own their homes, as compared with 59% in the County. Home ownership rates within the ARC area are increasing at a rate of 0.7% annually, slightly lower than the County rate of 0.9%.

The mean household income in the ARC area grew by 22%, from $63,191 to $80,707 (in constant 1995 dollars) between 1990 and 2000. In contrast, the mean household income in the County increased by 19% during the same period. This household income distribution is presented in Table 3-4.

As of 2000, the median ARC area population is 37.2 years, while the median for the County is 35.3 (see Table 3-5).

3.3.2. EMPLOYMENT

This section presents employment data for the region, County, and local area.

3.3.2.1. San Francisco Bay Area

The Bay Area has approximately 3.7 million full- and part-time jobs. The number of jobs in the Bay Area increased by 15% between 1990 and 2000, and employment is expected to grow by approximately 1.3% annually over the next 15 years (see Table 3-6). Services, wholesale and retail trade and manufacturing comprise 74% of the Bay Area's economy, and are expected to dominate through 2015.

Table 3-6. Employment Projections by Industry Sector

	1990		2000		2015		2000 to 2015
Industry Sector	**Number**	**Percent**	**Number**	**Percent**	**Number**	**Percent**	**Annual Change**
San Francisco Bay Area							
Agriculture and Mining	36,980	1.2%	37,780	1.0%	37,480	0.8%	-0.1%
Construction	148,360	4.6%	185,800	5.0%	214,680	4.8%	1.0%
Manufacturing	516,920	16.1%	558,790	15.1%	656,760	14.7%	1.1%
High Technology	273,790	8.5%	302,920	8.2%	338,890	7.6%	0.8%
Transportation/Public Utilities	189,390	5.9%	223,570	6.1%	280,830	6.3%	1.5%
Wholesale Trade	192,000	6.0%	199,620	5.4%	253,280	5.7%	1.6%
Retail Trade	534,960	16.7%	579,960	15.7%	659,420	14.8%	0.9%
Finance, Insurance, and Real Estate	228,310	7.1%	240,550	6.5%	270,670	6.1%	0.8%
Services	1,067,460	33.3%	1,390,860	37.7%	1,791,000	40.2%	1.7%
Business Services	370,550	11.6%	541,050	14.7%	692,890	15.5%	1.7%
Government	291,700	9.1%	271,660	7.4%	296,540	6.6%	0.6%
Total Employment	3,206,080		3,688,590		4,460,660		1.3%
Santa Clara County							
Agriculture and Mining	7,210	0.8%	7,430	0.7%	7,180	0.6%	-0.2%
Construction	31,060	3.5%	47,090	4.4%	51,590	4.1%	0.6%
Manufacturing	276,460	31.0%	286,260	26.6%	326,790	25.9%	0.9%
High Technology	203,800	22.9%	217,710	20.2%	232,020	18.4%	0.4%
Transportation/Public Utilities	23,680	2.7%	33,700	3.1%	42,420	3.4%	1.5%
Wholesale Trade	63,420	7.1%	62,410	5.8%	79,730	6.3%	1.6%
Retail Trade	129,700	14.6%	149,250	13.9%	163,950	13.0%	0.6%
Finance, Insurance, and Real Estate	35,150	3.9%	39,240	3.6%	44,480	3.5%	0.8%
Service	270,230	30.3%	390,470	36.2%	479,250	38.0%	1.4%
Business Services	109,580	12.3%	197,710	18.4%	222,230	17.6%	0.8%
Government	54,020	6.1%	61,370	5.7%	64,470	5.1%	0.3%
Total Employment	890,930		1,077,220		1,259,860		1.0%
Source: Design, Community & Environment 2002.							

The manufacturing sector comprises 15% of jobs in the Bay Area. According to ABAG, 54% of jobs in the manufacturing sector exist in the technology industry. The region benefits from a research and development infrastructure with nine research facilities, as well as other high technology and research and development companies, which attract highly skilled labor.

ABAG projects the number of business service jobs to grow at an annual rate of 1.7% from 2000 to 2015, faster than any other employment sector in the Bay Area.

3.3.2.2. Santa Clara County

Manufacturing, service, wholesale, and retail trade sectors comprise 82.5% of all jobs in the County. More than 20% of the 1 million jobs in the County exist in the manufacturing of high technology; however, this number is expected to fall to 18% of total employment by 2015 (see Table 3-6).

3.3.2.3. Ames Research Center Area

Almost 20% of all jobs in the County exist in the ARC area (Table 3-7), 44% of which are in the manufacturing and wholesale Sector. Major technology firms in the ARC area include Yahoo!, Network Appliances, Silicon Graphics, and Hewlett Packard.

Table 3-7 . Employment Projections by Industry Sector, Ames Research Center Area

	2000		2010		2015		2000 to 2015
	Number	Percent	Number	Percent	Number	Percent	Annual Change
Manufacturing and Wholesale	91,130	43.6%	99,420	43.6%	101,530	43.3%	0.7%
Retail	23,280	11.1%	24,210	10.6%	24,650	10.5%	0.4%
Service	58,990	28.2%	65,820	28.8%	68,430	29.2%	1.0%
Other	35,630	17.0%	38,810	17.0%	39,950	17.0%	0.8%
Total	209,030		228,260		234,560		0.8%

Notes:
ARC Area includes the combined jurisdictions of Mountain View and Sunnyvale.
Source: Design, Community & Environment 2002.

3.3.3. HOUSING AREAS ADJACENT TO ARC

This section describes existing housing conditions in areas adjacent to ARC.

Bay Area housing markets do not conform uniformly to geographic and jurisdictional boundaries. Therefore, data from the Metropolitan Transportation Commission's (MTC) Commuter Forecasts for the San Francisco Bay Area 1990–2020 was used to define this specific market. MTC organizes this data into "superdistricts" that do not correspond directly with jurisdictional boundaries. This definition assumes that workers in Superdistrict 9, which includes Sunnyvale and Mountain View, serves as a good example for this area (Design, Community & Environment 2002). Commuter forecasts for 2010 were used to conduct this analysis. The complete MTC data set is contained in Table 3-8.

Table 3-8 Commuters to Sunnyvale/Mountain View Superdistrict

Super-district	District of Residence	District of Work	2000 Number	% of Total	2010 Number	% of Total
1	Downtown SF	Sunnyvale/Mountain View	548	0.1%	599	0.1%
2	Richmond District	Sunnyvale/Mountain View	1,153	0.3%	1,197	0.2%
3	Mission District	Sunnyvale/Mountain View	1,513	0.4%	1,593	0.4%
4	Sunset District	Sunnyvale/Mountain View	910	0.2%	942	0.3%
5	Daly City/San Bruno	Sunnyvale/Mountain View	2,306	0.6%	2,510	0.6%
6	San Mateo/Burlingame	Sunnyvale/Mountain View	5,497	1.5%	6,095	1.5%
7	Redwood City/ Menlo Park	Sunnyvale/Mountain View	9,838	2.6%	11,180	2.7%
8	Palo Alto/Los Altos	Sunnyvale/Mountain View	22,128	5.9%	24,526	5.8%
9	Sunnyvale/Mountain View	Sunnyvale/Mountain View	74,583	19.9%	87,497	20.8%
10	Saratoga/Cupertino	Sunnyvale/Mountain View	56,462	15.0%	61,248	14.5%
11	Central San Jose	Sunnyvale/Mountain View	38,805	10.3%	43,348	10.3%
12	Milpitas/East San Jose	Sunnyvale/Mountain View	61,051	16.3%	67,192	16.0%
13	South San Jose/Almaden	Sunnyvale/Mountain View	29,403	7.8%	31,735	7.5%
14	Gilroy/Morgan Hill	Sunnyvale/Mountain View	5,568	1.5%	5,386	1.3%
15	Livermore/Pleasanton	Sunnyvale/Mountain View	5,950	1.6%	7,128	1.7%
16	Fremont/Union City	Sunnyvale/Mountain View	23,652	6.3%	25,349	6.0%
17	Hayward/San Leandro	Sunnyvale/Mountain View	3,992	1.1%	4,204	1.0%
18	Oakland/Alameda	Sunnyvale/Mountain View	1,558	0.4%	1,626	0.4%
19	Berkeley/Albany	Sunnyvale/Mountain View	467	0.1%	483	0.1%
20	Richmond/El Cerrito	Sunnyvale/Mountain View	522	0.1%	553	0.1%
21	Concord/Martinez	Sunnyvale/Mountain View	731	0.2%	825	0.2%
22	Walnut Creek/Lamorinda	Sunnyvale/Mountain View	592	0.2%	660	0.2%
23	Danville/San Ramon	Sunnyvale/Mountain	2,487	0.7%	2,997	0.7%

Super-district	District of Residence	District of Work	2000 Number	% of Total	2010 Number	% of Total
		View				
24	Antioch/Pittsburg	Sunnyvale/Mountain View	1,135	0.3%	1,419	0.3%
25	Vallejo/Benicia	Sunnyvale/Mountain View	386	0.1%	408	0.1%
26	Fairfield/Vacaville	Sunnyvale/Mountain View	534	0.1%	614	0.1%
27	Napa	Sunnyvale/Mountain View	61	0.0%	54	0.0%
28	St. Helena/Calistoga	Sunnyvale/Mountain View	65	0.0%	63	0.0%
29	Petaluma/Sonoma	Sunnyvale/Mountain View	59	0.0%	56	0.0%
30	Santa Rosa/Sebastopol	Sunnyvale/Mountain View	99	0.0%	84	0.0%
31	Healdsburg/Cloverdale	Sunnyvale/Mountain View	77	0.0%	72	0.0%
32	Novato	Sunnyvale/Mountain View	136	0.0%	140	0.0%
33	San Rafael	Sunnyvale/Mountain View	190	0.1%	198	0.0%
34	Mill Valley/Sausalito	Sunnyvale/Mountain View	107	0.0%	115	0.0%
	Santa Cruz County	Sunnyvale/Mountain View	6,514	1.7%	8,192	1.9%
	San Joaquin County	Sunnyvale/Mountain View	4,672	1.2%	6,027	1.4%
	Stanislaus County	Sunnyvale/Mountain View	5,389	1.4%	6,713	1.6%
	Sacramento County	Sunnyvale/Mountain View	3,216	0.9%	4,033	1.0%
	Monterey County	Sunnyvale/Mountain View	647	0.2%	940	0.2%
	San Benito County	Sunnyvale/Mountain View	894	0.2%	1,152	0.3%
	Placer County	Sunnyvale/Mountain View	639	0.2%	859	0.2%
	Merced County	Sunnyvale/Mountain View	603	0.2%	711	0.1%
	Yolo County	Sunnyvale/Mountain View	160	0.0%	176	0.0%
	Lake County	Sunnyvale/Mountain View	56	0.0%	62	0.0%
	Mendocino County	Sunnyvale/Mountain View	0	0.0%	0	0.0%
	Colusa County	Sunnyvale/Mountain	0	0.0%	0	0.0%

Super-district	District of Residence	District of Work	2000 Number	% of Total	2010 Number	% of Total
		View				
		Total	375,355	100%	420,961	100%
Note: Bolded superdistricts are within Housing Impact Area. Source: Design, Community & Environment 2002.						

The MTC data found workers traveling to Superdistrict 9 from Marin, Yolo, and Sacramento counties. The San Joaquin Council of Governments' Altamont Pass 2000 Commuter Survey found that 21% of drivers commuting through the Altamont Pass were destined for the County. These trends suggest that the housing area considered to be adjacent to ARC is very broad.

This broad adjacent housing area spreads across a large market, possibly masking effects of the local economy on local communities. To avoid this result, this document takes a more conservative approach and defines the area of effect for potential housing effects for a smaller area than the full commute-shed. The methodology for defining this smaller area of effect assumes that NASA Research Park (NRP) workers will search areas near their workplace for affordable housing before going farther. MTC data validates this assumption, showing that the vast majority of commuters to Superdistrict 9 in 2010 will reside in the immediate County.

Superdistricts that generated 1% or more of the total commuters to Superdistrict 9 were included in the Housing Impact Area. Santa Cruz, Stanislaus, and San Joaquin Counties fell above the 1% cutoff line. These counties are excluded from the Housing Impact Area because commuters from these areas come from an entire county, which is larger than a single superdistrict. Therefore, the greater than 1% standard does not apply. Table 3-9 contains the superdistricts included in the Housing Impact Area and lists the number of commuters from each superdistrict. Together, these superdistricts generate more than 88% of commuters to Superdistrict 9.

Table 3-9 . Definition of the Housing Impact Area

District of Residence	District of Work	Number[1]	Percent of All Commuters to Sunnyvale/Mountain View Superdistrict
Sunnyvale/Mountain View	Sunnyvale/Mountain View	87,497	20.8%
Milpitas/East San Jose	Sunnyvale/Mountain View	67,192	16.0%
Saratoga/Cupertino	Sunnyvale/Mountain View	61,248	14.5%
Central San Jose	Sunnyvale/Mountain View	43,348	10.3%
South San Jose/Almaden	Sunnyvale/Mountain View	31,735	7.5%
Palo Alto/Los Altos	Sunnyvale/Mountain View	24,526	5.8%
Fremont/Union City	Sunnyvale/Mountain View	25,349	6.0%
Redwood City/Menlo Park	Sunnyvale/Mountain View	11,180	2.7%
Livermore/Pleasanton	Sunnyvale/Mountain View	7,128	1.7%
San Mateo/Burlingame	Sunnyvale/Mountain View	6,095	1.4%
Gilroy/Morgan Hill	Sunnyvale/Mountain View	5,386	1.3%
TOTAL		370,684	88.1%
All Commuters to Sunnyvale/Mountain View Superdistrict		420,961	

[1] Forecasts for 2010 were used, as this is the closest date available to NRP's anticipated buildout year of 2013.
Source: Design, Community & Environment 2002.

3.3.3.1. Adjacent Housing Area Population Characteristics

This section concentrates on population and household trends in the adjacent housing area between 2000 and 2015.

Population characteristics of the area adjacent to ARC are summarized in Table 3-10. The population in this housing area is expected to increase from 2.7 million in 2000 to 3 million by 2015, a population increase of 0.8%. The number of households is expected to increase from 884,543 to 1 million between 2000 and 2015 at an average annual rate of 0.9%. The average household size is expected to decrease from 2.98 to 2.96, while mean household income will rise from $73,115 to $86,322 (in constant 1989 dollars, as calculated by MTC) (MTC 2000).

Table 3-10 . Housing Impact Area Characteristics

Housing Impact Area[1]	2000	2015	Total Change 2000 to 2015	Annual Change 2000 to 2015
Population	2,694,261	3,048,158	354,257	0.8%
Households	884,543	1,009,775	125,232	0.9%
Average Household Size	2.98	2.96	-0.02	0.0%
Average Workers Per Household	1.61	1.68	0	0.3%
Mean Household Income[2]	$73,115	$86,322	$13,207	1.1%

Notes:
1. Housing Impact Area includes the MTC Superdistricts listed in Table 3-9
2. In constant 1989 dollars

Source: Design, Community & Environment 2002.

3.3.3.2. Housing Market in the Housing Impact Area

The Bay Area housing market is one of the most competitive in the country, primarily due to rapid population and employment growth, which creates a lack of supply and great demand for housing. Based on available land supply and current local land use policies, ABAG estimates the potential for 308,800 housing units and 315,380 new households between 2000 and 2015, resulting in a net housing shortage of 6,580. MTC estimates the region will have 203,444 incoming commuters from areas outside the region by 2010, suggesting a regional housing shortage of more than 130,000 units (assuming 1.5 employed residents per household).

3.3.3.3. Housing Stock in Areas Adjacent to ARC

ABAG estimates the total number of occupied units in the adjacent areas at 884,543, of which 591,659 (66.9%) are single-family dwellings and 292,884 (33.1%) are multifamily dwellings (see Table 3-11). The total number of occupied units is expected to increase by nearly 13.8% to 1 million by 2015; however, the breakdown of single- and multifamily units is expected to remain the same.

The superdistricts of Livermore/Pleasanton, Sunnyvale/Mountain View, Central San Jose, and Milpitas/East San Jose are expected to absorb approximately 56% of new households in the areas adjacent to ARC between 2000 and 2015. The Livermore/Pleasanton Superdistrict will gain more than 23,000 units, representing nearly 19% of all units constructed in the adjacent area during this period. The Sunnyvale/Mountain View Superdistrict will gain more than 16,000 units, or 12.9% of all units constructed in the adjacent area. ABAG anticipates the County will fall short by 35,180 units between 2000 and 2015.

Table 3-11 . Housing Stock In Housing Impact Area

Superdistrict	2000		2015			
	Number of Units[1]	Percent of Total	Number of Units[1]	Percent of Total	Percent Change 2000 to 2015	Change as Percent of Total New Units in HIA
Sunnyvale/Mountain View	87,830	9.9%	103,887	10.3%	18.3%	12.9%
Milpitas/East San Jose	97,187	11.0%	111,580	11.1%	14.8%	11.6%
Saratoga/Cupertino	117,194	13.2%	126,525	12.5%	8.0%	7.5%
Central San Jose	97,646	11.0%	113,849	11.3%	16.6%	13.0%
South San Jose/Almaden	68,725	7.8%	76,134	7.5%	10.8%	5.9%
Palo Alto/Los Altos	69,446	7.9%	75,777	7.5%	9.1%	5.1%
Fremont/Union City	98,859	11.2%	109,304	10.8%	10.6%	8.4%
Redwood City/Menlo Park	77,383	8.7%	82,447	8.2%	6.5%	4.1%
Livermore/Pleasanton	61,653	7.0%	85,111	8.4%	38.0%	18.8%
San Mateo/Burlingame	79,568	9.0%	86,079	8.5%	8.2%	5.2%
Gilroy/Morgan Hill	29,052	3.3%	36,382	3.8%	25.2%	7.5%
Multi-Family Dwellings	292,884	33.1%	336,483	33.3%	14.9%	35.0%
Single-Family Dwellings	591,659	66.9%	673,292	66.7%	13.8%	65.6%
Total	884,543		1,009,075		14.1%	

1. Only includes occupied units
Source: Design, Community & Environment 2002

3.3.3.4. Rental Housing Market

According to a Real Facts survey, conducted in March 2001, the average monthly rent in the adjacent area for multifamily complexes of at least 50 units was $1,763, with an average vacancy rate of 3.9% (see Table 3-12). Between 2000 and the second quarter of 2001, the average rent increased by approximately 11%, while the vacancy rate increased 2.4%.

Affordable monthly rent (assuming 30% of income and including utilities) for households at the 25th percentile of household income is approximately $1,122. For those at the median household income, affordable monthly rent is approximately $1,951, and $3,122 for those at the 75th percentile (see Table 3-13). Tables 3-11 and 3-12 show the range of monthly rent for various unit types in the adjacent housing area.

Table 3-12 . Overview of the Housing Impact Area Rental Housing Market

Current Market Data					
Unit Type	**Number**	**Percent of Mix**	**Average Square Feet**	**Average Rent**	**Average Rent/ Square Feet**
Studio	6,672	6.3%	468	$1,356	$2.90
1 BR/1 BA	47,762	45.2%	698	$1,594	$2.28
2 BR Townhouse	2,740	2.6%	1,071	$1,983	$1.85
2 BR/1 BA	15,209	14.4%	878	$1,694	$1.93
2 BR/2 BA	29,171	27.6%	1,011	$2,062	$2.04
3 BR Townhouse	494	0.5%	1,237	$2,367	$1.91
3 BR/2 BA	3,701	3.5%	1,217	$2,364	$1.94
Totals	105,750	100.0%	826	$1,763	$2.13

Average Rent History							
Unit Type	**1998**	**1999**	**1998–1999 Change**	**2000**	**1999–2000 Change**	**2001**	**2000-2001 Change**
Studio	$897	$935	4.2%	$1,225	31.0%	$1,382	12.8%
1 BR/1 BA	$1,136	$1,187	4.5%	$1,536	29.4%	$1,650	7.4%
2 BR Townhouse	$1,402	$1,483	5.8%	$1,891	27.5%	$2,048	8.3%
2 BR/1 BA	$1,217	$1,278	5.0%	$1592	24.6%	$1,732	8.8%
2 BR/2 BA	$1,513	$1,574	4.0%	$2,031	29.0%	$2,139	5.3%
3 BR Townhouse	$1,632	$1,716	5.1%	$2,102	22.5%	$2,446	16.4%
3 BR/2 BA	$1,726	$1,773	2.7%	$2,195	23.8%	$2,396	9.2%
Totals	$1,263	$1,321	4.8%	$1,639	24.1%	$1,820	11.0%

Occupancy Rate	
Year	**Average Occupancy**
1998	95.1%
1999	96.5%
2000	98.5%
2000[1]	96.1%

Age of Housing Inventory	
Year	**Percent of Inventory**
Pre-1960s	3%
1960s	33%
1970s	36%
1980s	19%
1990s	9%

[1] Average of first two quarters of 2000

Source: Design, Community & Environment 2002

Table 3-13 . Rental Housing Affordability Analysis

Income and Affordability			
Income Level	**Estimated Household Income[1]**		**Monthly Affordable Rent[2]**
25th Percentile	$44,864		$1,122
Median	$78,057		$1,951
75th Percentile	$124,877		$3,122
Rents[3]			
Unit Type	**Average Low Rent**	**Average High Rent**	**Average Rent**
Studio	$1,330	$1,408	$1,382
1 BR/1 BA	$1,560	$1,663	$1,650
2 BR Townhouse	$1,955	$2,039	$2,048
2 BR/1 BA	$1,674	$1,732	$1,732
2 BR/2 BA	$2,005	$2,176	$2,139
3 BR Townhouse	$2,340	$2,421	$2,446
3 BR/2 BA	$2,325	$2,443	$2,396
Totals	$1,725	$1,839	$1,820

[1] From Table 3-4: Estimated 2000 Household Income Distribution
[2] Affordable rent is considered to be 30% of household income, including utilities
[3] From Real Facts survey of apartment complexes with 50 or more units in Housing Impact Area. Rents as of June 2001
Source: Design, Community & Environment 2002.

3.3.3.5. Ownership Housing Market

All full, verified, and confirmed sales in the Housing Impact Area between August 17, 2001, and August 31, 2001, are shown in Table 3-14. The cost median for a single-family home is $491,250, and the median cost of a condominium is $338,500, revealing some of the highest housing prices in the Bay Area.

Table 3-14 . Overview of Housing Impact Area For-Sale Housing Market

Single-Family			Condominiums		
Sale Price	**Number of Units**	**Percent of Total**	**Sale Price**	**Number of Units**	**Percent of Total**
Less than $200,000	4	0.7%	Less than $150,000	4	2.5%
$200,000 to $249,999	2	1.0%	$150,000 to $199,999	5	3.1%
$250,000 to $299,999	7	2.2%	$200,000 to $249,999	18	11.3%
$300,000 to $349,999	32	8.8%	$250,000 to $299,999	29	18.1%
$350,000 to $399,999	74	16.5%	$300,000 to $349,999	28	17.5%
$400,000 to $449,999	100	13.8%	$350,000 to $399,999	24	15.0%
$450,000 to $499,999	61	11.1%	$400,000 to $449,999	19	11.9%
$500,000 to $549,999	54	7.3%	$450,000 to $499,999	14	8.8%
$550,000 to $599,999	47	7.0%	$500,000 to $549,999	6	3.8%
$600,000 to $649,999	27	6.4%	$550,000 to $599,999	4	2.5%
$650,00 to $699,999	22	3.7%	$600,000 to $649,999	4	2.5%
$700,000 to $749,999	17	4.2%	$650,000 to $699,999	1	0.6%
$750,000 to $799,999	26	2.4%	$700,000 and above	4	2.5%
$800,000 to $849,999	14	2.7%	Total[1]	160	
$850,000 to $899,999	7	1.5%			
$900,000 to $949,999	6	1.9%	Median Sale Price	$338,500	
$950,000 to $999,999	8	1.2%	Average Sale Price	$358,216	
$1,000,000 to $1,499,999	22	4.0%			
$1,500,000 to $1,999,999	8	1.6%			
$2,000,000 and above	8	0.7%			
Total[1]	546	100.0%			
Median Sale Price	$491,250				
Average Sale Price	$598,951				

Notes:
[1] Represents all full, verified, and confirmed sales within the Housing Impact Area between August 17, 2001, and August 31, 2001
Source: Design, Community & Environment 2002

The County's 2000 household income distribution is used as a basis for determining housing affordability (see Table 3-15). According to this distribution, households at the 25th percentile of household income could afford less than 1% of the single-family homes and 1.3% of the condominiums sold during the last 2 weeks of August 2001 in the area adjacent to ARC. Households at the median household income can afford 2% of the single-family homes and 25% of the condominiums sold during the same period, and households at the 75th percentile can afford 41.8% of single-family homes and 82.5% of the condominiums sold.

Table 3-15 For-Sale Housing Affordability Analysis

		Single-Family Residence			Condominium		
Income Level	**Estimated Household Income[1]**	**Affordable Sales Price[2]**	**Number of Affordable Units[3]**	**Percent of All Sales**	**Affordable Sales Price[4]**	**Number of Affordable Units[5]**	**Percent of All Sales**
25th Percentile	$44,864	$163,401	1	0.2%	$139,700	2	1.3%
Median	$78,057	$284,295	11	2.0%	$272,704	40	25.0%
75th Percentile	$124,877	$454,821	228	41.8%	$460,313	132	82.5%

[1] From Table 3-4: Estimated 2000 Household Income Distribution
[2] Assumes 70% annual fixed interest, 30-year term, 20% of sales price down payment, 1.1% property tax, 0.75% of sales price annual insurance, 30% of household income available for principal, interest, taxes, and insurance
[3] Of all full, verified, and confirmed single-family home sales in Housing Impact Area from October 31, 2000, to November 15, 2000. Table 3-13 contains sales data
[4] Assumes 7.0% annual fixed interest, 30-year term, 20% of sale price down payment, 1.1% property tax, $250/month homeowners dues, 30% of household income available for principal, interest, taxes, and insurance
[5] Of all full, verified, and confirmed condominium sales in Housing Impact Area from August 17, 2001, to August 31, 2001
Source: Design, Community & Environment 2002

3.3.4. FISCAL ENVIRONMENT

This section discusses the existing fiscal conditions in the County, the cities of Sunnyvale and Mountain View, and the school districts serving Moffett Field.

3.3.4.1. Ames Research Center

Portions of ARC are located within the cities of Sunnyvale (specifically parcel 015-36-009) and Mountain View (parcels 116-07-010 and 116-12- 008). However, the majority of the ARC lies within unincorporated Santa Clara County. These multiple jurisdictions within the ARC create a complex tax system. More than 1/2 of Moffett Field is under federal exclusive jurisdiction.

Most of the Bay View area exists on lands over which the federal government has a proprietary interest, but has no legislative jurisdiction. Although this designation generally allows cities to provide law enforcement and public safety, the federal government has historically provided these services and is expected to continue to do so. Regardless of whether property is owned by the federal government or a non-federal entity, areas under exclusive federal legislative jurisdiction are not subject to property taxes.

However, Congress has waived the sovereign immunity of the federal government on exclusive jurisdiction land for other taxes. Under the Buck Act, 4 USC 105-110, state and local sales taxes, income taxes, and use taxes are applicable within areas of exclusive federal legislative jurisdiction. Such taxes may not be levied on the federal government or any federal instrumentality. However, private for-profit corporations in exclusive federal legislative jurisdiction and nonprofit entities are subject to these taxes.

Areas under partial legislative jurisdiction or proprietary interest are subject to state and local taxes. Therefore, nonfederal entities in these areas are subject to all taxes, including property tax, unless the entities have another status (e.g., nonprofit or state entities) that would otherwise leave them exempt.

3.3.4.2. Santa Clara County

According to the Fiscal Year 2001 Recommended Budget (FY 2001 Budget), the County anticipates $462.7 million in General Fund Unallocated Revenues for FY 2000. Motor vehicle in-lieu fees and secured property taxes represent the two largest unallocated revenue sources, with $133 million and $180 million, respectively, in revenues for FY 2000.

The FY 2001 Budget reports that County revenue has grown in conjunction with the expansion of Silicon Valley. Three of the largest revenue sources of the County General Fund are secured property tax, motor vehicle in-lieu fees, and public safety sales tax, all of which are expected to increase between FYs 2000 and 2001 and result in a $6 million surplus. However, the FY 2001 Budget reports that lease, salary, and employee benefits costs have also risen more than expected.

3.3.4.3. The City of Sunnyvale

The FY 2005/2006 Budget (FY 2005/2006 Budget) for the City of Sunnyvale projects total revenue of $200.2 million, and a general fund revenue of $96.2 million. The two largest sources of revenue are sales tax, which comprises 14.2% of total revenue, and property tax, which comprises 10.5% of total revenue. Transient occupancy tax, utility tax, gas tax, and other taxes encompass 8.5% of the total revenue. State-shared revenues, largely motor vehicle in-lieu fees, comprise an additional 5.3% of total revenue. Expenditures for FY 2000/2001 totaled $197.6 million, with a total operating budget of $157.9 million.

3.3.4.4. The City of Mountain View

The FY 2005/2006 Budget for the City of Mountain View projects $158 million in total revenue and $69.3 million in General Fund revenues for FY 2000/2001. Sales tax and property tax, the two largest revenue sources, comprise 13.1% and 6.9% of the city’s total revenue, respectively. Transient occupancy tax, business license tax, and utility user’s tax make up another 4.7%, while intergovernmental revenue, primarily Motor Vehicle License Fees, comprises 3.1% of total revenue for the city. The city estimates $157.7 million in total expenditures in FY 2000/2001, $65.7 million of which is for general operations. The general fund of the city is somewhat unstable, primarily due to decreasing sales tax revenue.

3.3.4.5. Mountain View-Whisman School District

The Mountain View-Whisman School District serves elementary and middle school students from Moffett Field. In FY 2000/2001, the district projected $30.6 million in revenue and $30.4 million in expenditures for its general fund. Combined with additional federal, state, and local sources, the district will have an ending balance of $2.1 million.

The revenue limit, which is determined by dividing average daily attendance by the total number of school days in the school year, comprises $20.6 million, or 67% of the general fund. The general fund also receives federal funds of $1.2 million and state funds of $5.1 million. Local income sources, the largest being lease revenue and Special Education Local Plan Area transfers, comprise the final $3.7 million, or 12%, of the general fund.

3.3.4.6. Mountain View-Los Altos Union High School District

The Mountain View-Los Altos Union High School District serves high school students from Moffett Field. FY 2002 Budget for the district projects $29.4 million in revenue and $28.8 million in expenditures for its general fund, resulting in a general fund balance of $423,715 after interfund transfers.

The revenue limit of $24.8 million makes up more than 84% of total general fund income. As a State Basic Aid District, the state will only pay a Basic Aid amount ($120 per average daily attendance or $24,000 per district, whichever is greater) for increased average daily attendance. Federal sources contribute approximately $454,102 to the general fund.

3.4. EXISTING SITE CONDITIONS

3.4.1. EMPLOYEE POPULATION AND INCOME LEVELS AT NASA AMES RESEARCH CENTER

In December 2008, 3,000 people were employed at ARC. Resident Agencies and tenants include an additional 750 people employed at the Center.(Anderson personal communication). The average salary of ARC civil service employees (excluding top management) was $80,430 in FY 2008 (Cunningham personal communication). In 2008, the median household income in the County was $74,335, $83,316 in Mountain View, and $74,409 in Sunnyvale.

3.5. ENVIRONMENTAL MEASURES

The following environmental measures are identified as mitigation measures in the NASA Ames Development Plan Final Programmatic Environmental Impact Statement, which was finalized in July 2002 (Design, Community & Environment 2002). These measures are intended to reduce potential socioeconomic effects due to implementation of Alternative 5 (as described in the EIS).

3.5.1. MITIGATION MEASURES FROM NADP EIS

3.5.1.1. Mitigation Measure SOCIO-1a

NASA will continue to attempt to acquire the rights to occupy as much of the Department of Defense (DOD) housing located at Moffett Field as possible to bolster the projected supply provided under each of the alternatives.

3.5.1.2. Mitigation Measure SOCIO-3

NASA and the Mountain View-Los Altos Union High School District will negotiate an agreement whereby in any given year, should the Mountain View-Los Altos Union High School District's per student operating revenues decrease below a pre-determined baseline as a direct result of enrollment generated by the NADP, NASA or its partners will compensate the District for the shortfall associated with these students. The baseline would be set to the District's per student operating revenues in the year prior to when students residing at ARC first begin attending classes in the District, and would be adjusted for cost of living and inflationary changes over time.

Chapter 4. Land Use

4.1. OVERVIEW

This chapter describes existing and planned land uses within the NASA Ames Research Center (ARC) as a whole, and in the surrounding area. It also includes a discussion of existing conditions relative to airfield land uses. The primary existing land uses at ARC are office, research and development (R&D), maintenance, storage, retail, and open space. Uses in surrounding areas include office, R&D, light industrial, residential, commercial, and open space. In July 2002, NASA published a Final Programmatic Environmental Impact Statement (EIS) and adopted a development plan for NASA Ames (Design, Community & Environment 2002).

The NASA Ames Development Plan (NADP) is a result of a five year planning effort involving NASA, local cities, community groups and planned NASA Research Park (NRP) partners. The NADP provides for collaboration among NASA, universities, and businesses to develop a shared-use R&D campus that comprises academia, industry, and non-profit organizations. The preferred alternative (Mitigated Alternative 5) under the NADP provides for new construction of approximately 2.5 million square feet of educational, office, R&D, museum, conference center, housing and retail space in the NRP area. The NADP also included the addition of approximately 1.2 million square feet of new development (primarily housing) in the Bay View area, and approximately 500,000 square feet of new high-density office and R&D space in the Ames Campus. It is estimated that implementation of planned development activities under the NADP will generate 7,088 new employees, approximately 3,000 students, and house 4,909 residents in 1,930 housing units.

4.2. REGULATORY REQUIREMENTS

The ARC site is located primarily within unincorporated Santa Clara County. Ames is operated by the federal government, which pursues a policy of full cooperation with local regulatory and planning agencies and governments. Because the complex has been located on the present site since 1940, it has been included in the planning efforts of local and regional agencies for some time.

4.2.1. LOCAL AND REGIONAL LAND USE AUTHORITIES

Land use designations and policies by the following regulatory authorities may affect NASA operations at ARC and are guided by the following general plans and land use plans of the cities of Mountain View and Sunnyvale.

4.2.1.1. City of Mountain View

ARC is classified as major institutional land use in the Land Use Element of the City General Plan, City of Mountain View. Much of the city's urban planning is focused on the North Bayshore Area. The North Bayshore Area is adjacent to the western boundary of ARC, at the northern end of the site. Excluding a regional park, lands in this area are designated as open space (>50%), residential (15%), and industrial/commercial (12 %).

4.2.1.2. City of Sunnyvale

Portions of Sunnyvale adjacent to ARC include a large Lockheed Martin Corporation complex (to the east) and a golf course and residences (to the south). Recently, redevelopment including new office buildings has taken place within the Lockheed complex.

A portion of the City of Sunnyvale is under the airfield approach path for the ARC airfield. Hence, the city's general plan contains sections addressing airfield use and associated noise levels. Sunnyvale's noise criteria follow the California State guidelines closely. See Chapter 16, Noise and Vibration, for additional discussion.

4.2.1.3. Mid-Peninsula Regional Open Space District

The Mid-Peninsula Regional Open Space District owns the salt marsh adjacent to and northwest of ARC (Figure 1-3). This area is designated as open space for recreational use, and includes the 21-hectare (54-acre) Stevens Creek Shoreline Nature Study Area.

In a collaborative effort with the Santa Clara Valley Water District and the City of Mountain View, the Mid-Peninsula Regional Open Space District is developing the Stevens Creek Park chain. This is a linear, streamside park plan that includes the Stevens Creek corridor along the western boundary of ARC. The Steven Creek Trail that runs through this park chain provides access for recreation opportunities, such as walking and biking.

4.2.2. STATE REGULATIONS

4.2.2.1. The Coastal Zone Management Act

The coastal zone was specifically mapped by the state legislature and covers a large area. On land, the coastal zone varies in width from several hundred feet in highly urbanized areas up to 8 kilometers (5 miles) in certain rural areas, and offshore the coastal zone includes a 4.8-mile (3-mile)-wide band of ocean. The Coastal Commission was established by the Coastal Zone Management Act does not include San Francisco Bay, where development is regulated by the Bay Conservation and Development Commission (BCDC). The BCDC, in addition to the Coastal Commission, is one of

California's two designated coastal management agencies for administering the federal Coastal Zone Management Act in California.

The most significant provisions of the federal Coastal Zone Management Act give state coastal management agencies regulatory control (federal consistency review authority) over all federal activities and federally licensed, permitted, or assisted activities, wherever they may occur (that is, landward or seaward of the respective coastal zone boundaries fixed under state law) if the activity affects coastal resources. Examples of such federal activities include outer continental shelf oil and gas leasing, exploration, and development; designation of dredge material disposal sites in the ocean; military projects at coastal locations; U.S. Army Corps of Engineers fill permits; certain U.S. Fish and Wildlife Service permits; national park projects; highway improvement projects assisted with federal funds; and commercial space launch projects on federal lands. Federal consistency is an important coastal management tool because it is often the only review authority over federal activities affecting coastal resources given to any state agency.

4.2.2.2. San Francisco Bay Conservation and Development Commission

BCDC is a California state agency that was established to accomplish two primary goals: first, to prevent the unnecessary filling of San Francisco Bay, and second, to increase public access to and along the Bay shoreline. The commission is responsible for carrying out two state laws—the McAteer-Petris Act and the Suisun Marsh Preservation Act—and two plans—the San Francisco Bay Plan and the Suisun Marsh Protection Plan. These laws and plans were adopted to protect the Bay and the Suisun Marsh as great natural resources for the benefit of the public and to encourage development compatible with this protection.

It is necessary to obtain BCDC approval prior to undertaking any of the following activities:

- Filling. Placing solid material, building pile-supported or cantilevered structures, disposing of material, or permanently mooring vessels in the Bay or in certain tributaries of the Bay
- Dredging. Extracting material from the Bay bottom
- Shoreline Projects. Nearly all work, including grading, on the land within 30 meters (100 feet) of the Bay shoreline
- Suisun Marsh Projects. Nearly all work, including land divisions, in the portion of the Suisun Marsh below the 3-meter (10-foot) contour level
- Other Projects. Any filling, new construction, major remodeling, substantial change in use, and many land subdivisions in the Bay, along the shoreline, in salt ponds, duck hunting preserves, or other managed wetlands adjacent to the Bay

Since portions of ARC are within this area, proposed activities by NASA are routinely referred to BCDC for consistency with the San Francisco Bay Plan. The San Francisco Bay Plan contains policies regarding development of the Bay coastal areas, and NASA operations are consistent with these policies. ARC has been designated as an Airport Priority Use Area by BCDC. Work within 3 meters (100 feet) south of the BCDC line or any activity that would affect the airfield priority use requires a consistency determination by BCDC.

4.2.3. FEDERAL REGULATIONS

4.2.3.1. NASA Ames Development Plan

All federal regulations applicable to ARC are addressed in the NADP Programmatic Environmental Impact Statement and are identified in *Chapter 2 Existing Facilities, Operations and Their Impacts*.

4.2.3.2. Federal Aviation Administration

ARC Airfield is owned by NASA and is currently used by NASA and the California Air National Guard, with some limited use by other resident agencies and tenants. Since taking over the airfield from the Navy, NASA has primarily used the facility for Rotorcraft and transient research aircraft. ARC has applied Federal Aviation Administration (FAA) civilian standards to determine adjacent land uses and airport operating clearances for Moffett Field. The controlling documentation regarding such clearances and design criteria are based on FAA Regulations Part 77. The following regulations govern other aspects of airfield operations: Part 99, which covers security control of air traffic, and Part 150, which governs airport noise compatibility planning and contains both Noise Exposure Maps and a Noise Compatibility Program to reduce and prevent noise exposure impacts.

Part 77 addresses maximum building heights adjacent to the runways. Specifically, no obstruction may penetrate the “Transitional Surface,” which is determined by calculating a slope of 7:1 extending from the edge of the “Primary Surface,” which is an imaginary surface extending 152 meters (500 feet) on either side of the centerline of the runway. For example, building heights at the eastern edge of NASA Research Park Parcels 7 and 8 may not exceed 22 meters (73 feet), according to the transitional surface slope. At the western edge of the parcels, building heights may not exceed 36 meters (120 feet). Furthermore, no buildings may be constructed within the “Building Restriction Line,” which is located 234 meters (769 feet) from the centerline of the runway, and the taxiway Object Free Area prohibits the placement of buildings within 59 meters (193 feet) of the taxiway centerline.

Moffett Federal Airfield generally operates in accordance with Federal Aviation Regulation Part 139, which describes the procedures, standards, equipment, facilities, and personnel at the airfield. While Moffett Federal Airfield is not currently certified under Federal Aviation Regulation Part 139, nor is it required to be, NASA strives to meet its standards to the extent feasible and practicable.

4.3. REGIONAL SETTING

ARC is surrounded by industrial/commercial, residential, recreational, and wildlife protection land uses. Surrounding land use is primarily industrial/commercial type uses.

Residential use in the immediate vicinity of ARC includes the Santiago Villa Mobile Home Park and DOD housing (US Army Corps of Engineers). Santiago Villa is off site, across Stevens Creek. The DOD housing accommodates approximately 590 families and is located to the southwest.

Open space near ARC includes the wetlands and tidal marshes of the San Francisco Bay National Wildlife Refuge, Mid-Peninsula Open Space District, Stevens Creek Nature Study Area, San Francisco Bay Trail, Stevens Creek Regional Trail, Shoreline Park at Mountain View, Sunnyvale Baylands Park, various neighborhood parks, and several private recreational areas.

4.4. EXISTING SITE CONDITIONS

4.4.1. AMES RESEARCH CENTER

ARC consists of the 752-hectare (1,857-acre) NASA-administered portion of the former NASA Moffett Field and the original NASA Ames Campus. ARC is composed of the original ARC campus, the airfield, airfield support facilities, Bayview planning area, barracks, support facilities for current and former military personnel, and open space. Portions of Moffett Field not under NASA control consists of two DOD-administered housing areas. These are the Berry Court Military Housing area/Westcoat Village where former housing units have recently been removed and new housing is currently under construction (Anderson 2004) and the former Orion Park Military Housing area. The US Army Reserve has demolished the Orion Park housing facilities to allow for the construction of the Reserve Readiness Training Center.

For purposes of this ERD, ARC has been divided into four major planning areas: the 86-hectare (213-acre) NASA Research Park, the 95-hectare (234-acre) Ames Campus, the 385-hectare (952-acre) Eastside/Airfield, and the 38-hectare (95-acre) Bay View area. The remaining 144 hectares (357 acres) of NASA-administered land consists of wetlands areas along the northern boundary of ARC. Figure 4-1 shows the land uses within ARC.

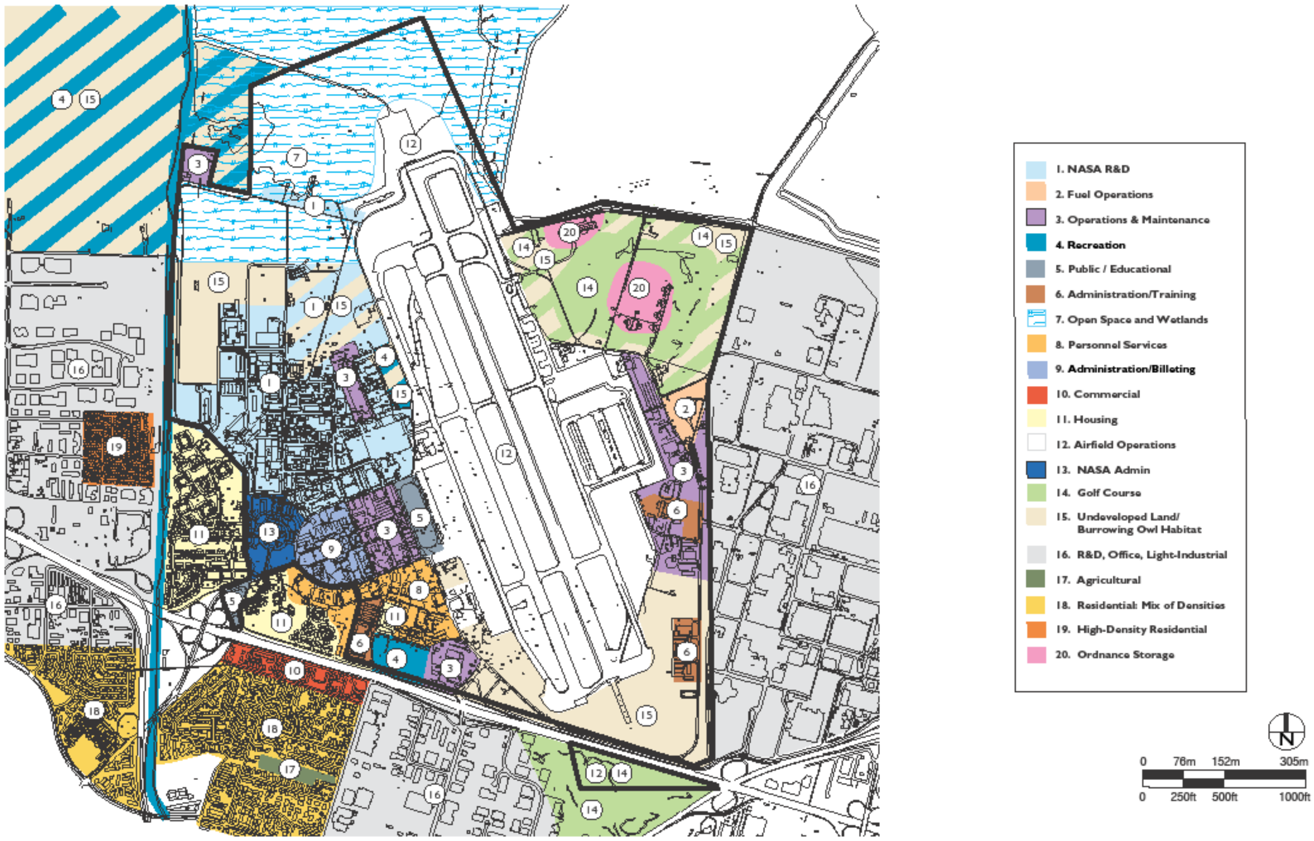

Figure 4-1 Existing Land Use

4.4.2. NASA RESEARCH PARK

The NASA Research Park consists of 86 hectares (213 acres) of land on the southwest edge of ARC. This area includes 29 hectares (72 acres) of the Shenandoah Plaza National Historic District, which is the entire Historic District under NASA control except for Hangars 2 and 3, which are in the Eastside/Airfield area. The NASA Research Park area lies adjacent to the Ames Campus and Eastside/Airfield areas. Current uses include office, R&D, education, retail, business services, barracks, vehicle maintenance facilities, airfield operations, and storage. There are also 9 hectares (22 acres) of burrowing owl habitat adjacent to the airfield have been established as a preserve. There are approximately 5.6 hectares (14 acres) of active open space.

4.4.3. AMES CAMPUS

The Ames campus area encompasses 95 hectares (234 acres) in the northwest portion of ARC. The Ames campus area contains 40 major technical facilities and laboratories, and 48 other major supporting and administrative buildings and structures. Current programs of the Ames campus are directed toward research and development in exploration, life and space sciences, and information technology and aeronautics.

4.4.4. EASTSIDE/AIRFIELD

The Eastside/Airfield area consists of 385 hectares (952 acres) on the east side of ARC. The primary land use in the Eastside/Airfield area is the runway, which is currently utilized by the California Air National Guard, ARC aircraft, and aircraft from other federal agencies, partners, and tenants. Hangars 2 and 3, which are part of the Shenandoah Plaza National Historic District, are in this area.

4.4.5. BAY VIEW

The Bay View area consists of 38 hectares (95 acres) on the northwest edge of ARC. The Bay View area is currently undeveloped, and is composed primarily of nonnative grassland.

4.4.6. AIRFIELD OPERATIONS

Airfield operations are currently restricted to aircraft operated by or for the benefit of agencies of federal, state, and local governments. Due to the nature of operations at the airfield, there are several areas that are designated as safety clearance zones based on the criteria established under FAR Part 77. These areas, shown in Figures 4-2 and 4-3 delineate areas on the ground that must be kept clear of structures or any other obstruction.

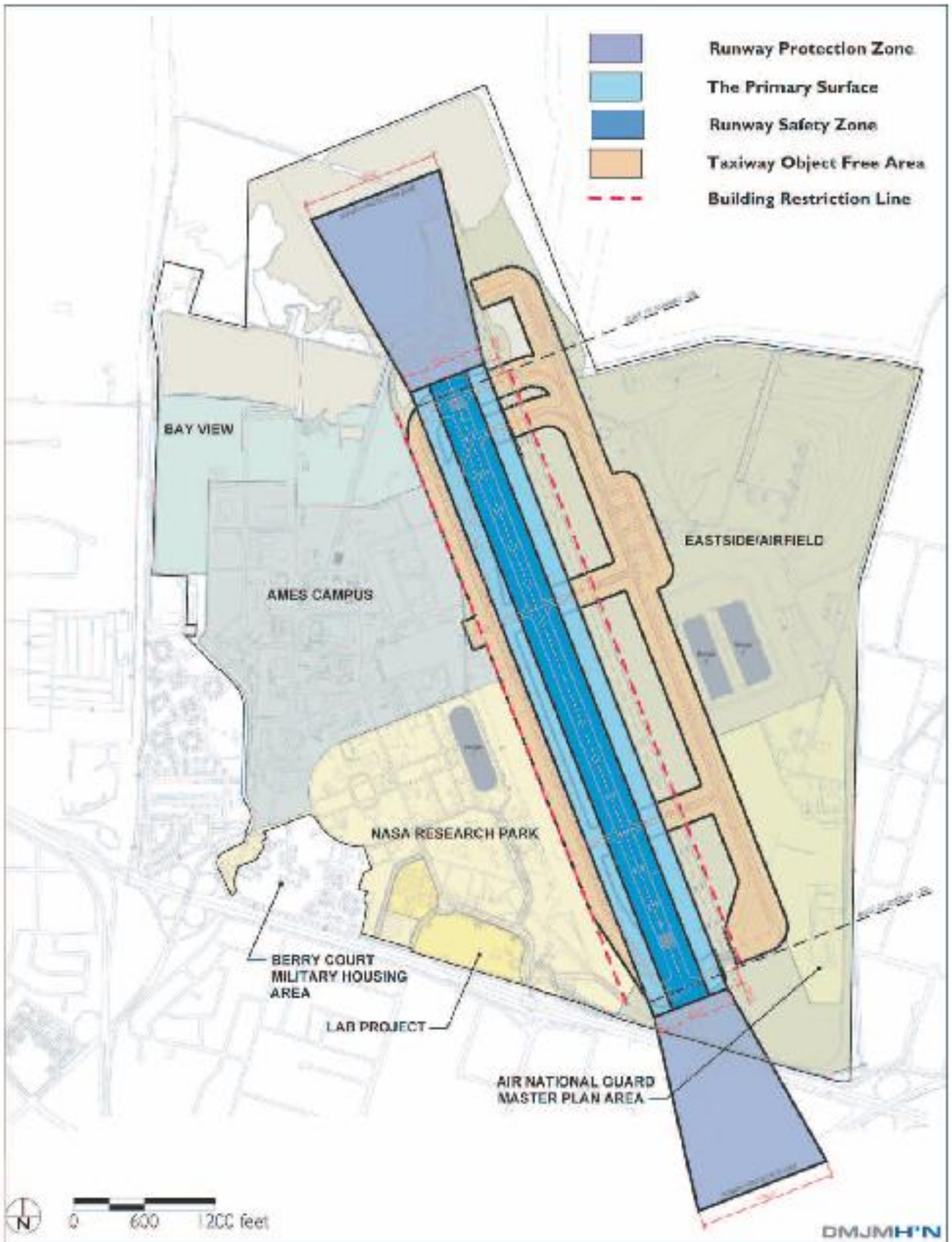

Figure 4-2 Minimum Operating Clearances Runway 32 Left

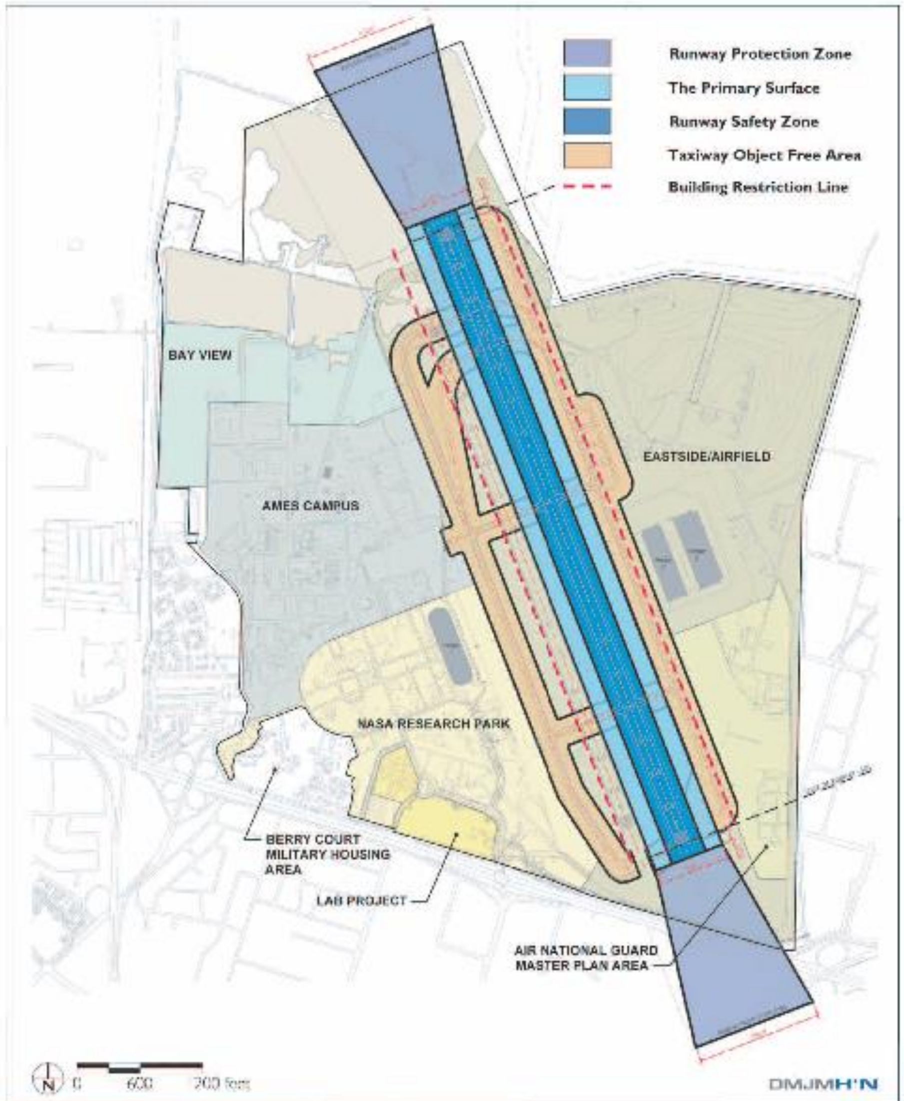

Figure 4-3 Minimum Operating Clearances Runway 32 Right

Moffett Federal Airfield currently operates in accordance with these regulations, with the exception of Hangars 1, 2, and 3. Hangars 1, 2, and 3 are considered to be in violation of federal airspace regulations because they exceed the Transitional Surface slope (as described in the Federal Regulations section above), but because they predate existing federal regulations, and because they are part of the Shenandoah Plaza Historic District (see Chapter 7, Cultural Resources), NASA has no plans. The Navy has developed an Engineering Evaluation Cost Analysis to address remediation alternative to address contamination associated with the Hangar 1 siding.

4.4.6.1. Areas with Safety Clearance Zones

These areas include the following:

- Outdoor Aerodynamic Research Facility (OARF). Aerodynamic testing of experimental aircraft is conducted on OARF's suspended platform. OARF is surrounded by a 76 meter (250 foot) Primary Exclusion Zone, a 229 meter (750 foot) Primary Clearance Zone, and a 457 meter (1,500 foot) Secondary Safety Zone. When operational, activities within the Primary Exclusion Zone require safety clearance due to elevated noise levels and the potential for projectiles. The Primary Clearance Zone defines the area in which nonaerodynamic fragments from a damaged test vehicle would likely land. A 457 meter (1,500 foot) Secondary Safety Zone delineates the area within which aerodynamic fragments (i.e., parts of the aircraft itself) or complete test vehicles would likely land due to an accident. Although unlikely, projectiles may travel beyond these zone boundaries during an accident.
- Low-Altitude Testing. NASA also performs low-altitude test flights and helicopter tests above the northern portion of the site (within the boundaries of ARC). These operations are occasional and carefully monitored.
- Ordnance and Weapons Storage. Storage occurs near the northern perimeter on the northeast side of the runway. Due to the nature of explosives, stringent safety zones have been established around the ordnance bunkers in accordance with U.S. Air Force regulations. The California Air National Guard and other Resident Agencies actively use the bunkers. The California Air National Guard ensures full regulatory compliance. The need for secure ordnance and weapons storage areas has significantly increased in the Bay Area because of numerous base closures. Hence, this land use continues at ARC.
- Magnetic Test Facility. Testing in this facility requires a magnetic field-free environment. The facility, however, does not generate magnetic fields itself and is not considered a safety threat.
- Moffett Federal Airfield. NASA is responsible for managing the emergency services at Moffett Federal Airfield, including emergency/disaster preparedness. Operational responsibility for these services is the responsibility of the 129th Rescue Wing of the California Air National Guard. The Moffett Federal Airfield Fire Chief oversees all aspects of fire protection, including crash, fire, rescue, and structural fire aspects of fire services.

4.4.7. SURROUNDING LAND USES

Land uses in the area surrounding ARC are a mix of industrial, office, residential, agricultural, and park uses. These surrounding land uses are illustrated in Figure 4-1 (Figure 3.2-1 from the EIS) and described below:

Stevens Creek (as mentioned above) and the recreational trail that runs along the levee beside it are immediately west of ARC. A strip of agricultural land that is used as a Christmas tree farm borders the central portion of Stevens Creek.

Farther to the northwest is a mixture of office and light industrial buildings, with some supporting commercial, retail, and entertainment services on the north side of Shoreline Boulevard.

Directly west of ARC and across Stevens Creek is the Santiago Villa Mobile Home Park, with approximately 358 units.

South of ARC and U.S. Highway 101 are a wide variety of uses, including general light industrial, office, commercial, and residential. Residential uses are a mixture of high-density multi-family units and detached single-family homes. Across U.S. Highway 85 to the west of the park is low-density residential and general industrial land.

Southeast of ARC is the Sunnyvale Municipal Golf Course, which is dedicated as parkland. Fourteen hectares (35 acres) of the Sunnyvale Municipal Golf Course belongs to ARC. Further south of the golf course, there is a mix of industrial and medium-density residential land uses.

The area immediately to the east of ARC is characterized by industrial and office uses. Beyond it, uses include low- and medium-density residential and general business.

Mid-Peninsula Regional Open Space District's Stevens Creek Nature Study Area is adjacent to the northwest corner of ARC. It consists of pickleweed salt marsh and open water (stormwater retention pond) habitat.

Open space and recreational land uses surrounding ARC include the Bay Trail, the Stevens Creek Regional Trail, the Shoreline Amphitheater, various neighborhood parks, a golf course, and several private recreational areas.

4.4.8. ENVIRONMENTAL MEASURES

4.4.8.1. Land Use Compatibility

Land use compatibility at ARC should address general conformance with local and regional regulatory plans and policies, including Sunnyvale and Mountain View General Plans and BCDC's Bay Plan, as well as compliance with other state and federal plans and policies as they apply to ARC. See Section 4.2 above and *Chapter 2 Existing Facilities, Operations and Their Impacts.*

The major land use considerations for the areas surrounding Moffett Field are to ensure that any new future land uses do not interfere with safety clearances established by federal regulations and will not be adversely affected by the noise generated by airfield operations.

Currently, there are no proposed changes to airfield operations, and no changes to existing noise levels would occur. Future development plans at NASA would evaluate potential effects on the new development where noise exposure due to airfield operations may potentially be an issue.

ARC has applied FAA civilian standards to determine adjacent land uses and airport operating clearances for Moffett Federal Airfield. The controlling documentation regarding such clearances and design criteria are based on FAA Regulations Part 77. In addition, any future development at ARC would comply with the requirements of FAA Regulations Part 77. As described above, FAR Part 77 sets out a number of minimum operating clearances, based on the runway centerline and the wingspan of the largest aircraft expected to use the airfield, which establish runway protection zones, runway safety zones, and taxiway Object Free Areas.

Chapter 5. Recreation

5.1. OVERVIEW

This section summarizes regulatory and planning guidance relevant to recreation, and describes existing recreational facilities at ARC and in nearby communities. Information regarding existing recreational facilities in Section 5.3, Regional Setting, was obtained from the NASA Ames Development Plan Final Programmatic Environmental Impact Statement (Design, Community & Environment 2002).

ARC and the neighboring communities of Mountain View and Sunnyvale offer a wide range of recreational opportunities, including hiking, bicycling, athletics, and bird-watching. The planning vision embodied in both cities' general plans and in NASA's environmental commitments is intended to ensure that outstanding recreational opportunities continue to be available as development proceeds in the future.

5.2. REGULATORY REQUIREMENTS

A variety of regulations and planning guidelines pertain to recreational use on and around the ARC campus. The basic regulatory framework is established in accordance with the federal Coastal Zone Management Act, the California Coastal Act, and the state's McAteer-Petris Act. Direct guidance is provided by the San Francisco Bay Plan, the Bay Trail Plan, the City of Mountain View's Open Space Vision Statement, and the general plans of the Cities of Mountain View and Sunnyvale.

5.2.1. FEDERAL REGULATIONS

5.2.1.1. Coastal Zone Management Act

The Coastal Zone Management Act (CZMA) was enacted in 1972 to regulate development affecting coastal waters and adjacent shorelines. The CZMA also applies to the inland belt that has "significant and direct impacts on coastal waters." Under the CZMA, states are encouraged voluntarily to develop coastal zone management programs (CZMPs) to preserve and protect the unique features relevant to each coastal area. In many places, the effort to preserve and protect coastal resources includes providing for planned and managed recreational use.

The Office of Ocean and Coastal Resource Management of the National Oceanic and Atmospheric Administration approve CZMPs. All federal projects and projects that require a federal permit must be consistent with approved CZMPs. In California, local coastal programs developed under the California Coastal Act serve as each area's CZMP.

For the Don Edwards San Francisco Bay National Wildlife Refuge, the South Bay Salt Pond Restoration Project has an approved Environmental Impact Statement/Report which evaluated the impacts of the transfer of over 10,000 acres of salt evaporation ponds to tidal waters and wildlife habitat functions.

5.2.2. STATE REGULATIONS AND PLANS—MCATEER-PETRIS ACT AND SAN FRANCISCO BAY PLAN

The McAteer-Petris Act, passed by the State of California in 1965, established the San Francisco Bay Conservation and Development Commission (BCDC) as the state agency responsible for regulating development in and around San Francisco Bay (Bay) and mandated the planning effort that resulted in development of the San Francisco Bay Plan (Bay Plan). Shortly thereafter, the federal CZMA encouraged states to voluntarily develop CZMPs, as described above. Partly in response to these federal recommendations, the California Coastal Act of 1976 established the California Coastal Commission and recognized the BCDC as the state agency with primary responsibility for enforcing the state's CZMP within the Bay Area.

The Bay Plan describes the values associated with the Bay and presents policies and planning maps to guide future uses of the bay and its shoreline. Under the Bay Plan, priorities for suitable uses of the shoreline include ports, water-related industry, airports, wildlife refuges, and water-related recreation. The Bay Plan also proposes adding land to the Bay wildlife refuge system; encourages public access via marinas, waterfront parks, and beaches; and requires the provision of maximum access along the waterfront and certain shorelines, except where public uses conflict with other significant uses, or where public use is inappropriate because of safety concerns.

BCDC is responsible for implementing the policies of the Bay Plan. All federal projects in the Bay Area's shoreline regions are required to submit a consistency determination to BCDC and to demonstrate consistency with the Bay Plan and the appropriate Bay Plan maps. Moffett Field is an airport priority use area and it is recommended that the site be evaluated for use as a commercial airport if the site is ever declared surplus by the military (San Francisco Bay Conservation and Development Commission 2003). (The Bay Plan specifically states that it "does not advocate the closing of any military installation.") The Bay Plan also recommends that the salt ponds adjacent to the north end of Moffett Field be reserved for possible airport expansion if and when these ponds are not needed for salt production.

5.2.3. REGIONAL AND LOCAL PLANS

5.2.3.1. Bay Trail Plan

Senate Bill 100, enacted in 1987, directed the Association of Bay Area Governments (ABAG) to develop a plan and identify an alignment for a trail envisioned as a "ring around the Bay." The resulting Bay Trail Plan, adopted by ABAG in July 1989, includes a proposed alignment; a set of policies to guide the future selection, design, and implementation of specific routes; and strategies for financing and implementation. Since the adoption of the Bay Trail Plan, most of the jurisdictions along the Bay Trail alignment have passed resolutions in support of the Bay Trail and have incorporated the trail into their general plans. In 1990, the San Francisco Bay Trail Project was created as a nonprofit organization dedicated to planning, promoting, and advocating implementation of the Bay Trail. The San Francisco Bay Trail Project is administered by ABAG and is housed at ABAG's offices in Oakland. The NASA Ames Development Plan recognized the value of the Bay Trail and committed to ensure that Ames activities would not preclude the trail from development.

5.2.3.2. City of Mountain View

Open Space Vision Statement

The City of Mountain View regards its parks and other open spaces as some of its most important resources and has developed an Open Space Vision Statement to guide the long-term acquisition, development, and preservation of parkland. The Open Space Vision Statement includes an inventory of existing parkland resources in the city and evaluates the open space needs of each of the 10 planning areas within the city.

Specific issues addressed for each planning area include the following:

- Status as compared to the standards of the National Recreation and Parks Association, which establishes guidelines for the minimum acreage of parkland based on population served
- Potential for existing parkland resources to be lost through sale and the likely effects of such losses on the city's park system
- Potential costs of acquiring additional open space

The City of Mountain View requires that developers provide at least three acres of parkland for each 1,000 persons who will live in a new housing project, regardless of whether the units will be owned or rented.

General Plan

The *Environmental Management* chapter of the Mountain View General Plan (City of Mountain View 1992) includes four key goals for open space and recreational facilities within the city, as summarized below.

- Acquire enough open space to satisfy local needs

- Improve open space areas to provide diverse recreational and leisure opportunities; this would include developing a system of urban trails and improving and expanding wildlife habitats adjacent to Shoreline at Mountain View Regional Park
- Make open spaces and recreation facilities available for different uses, including recreation programs, activities that promote awareness and understanding of Mountain View's culture, opportunities for residents to participate in cultural arts events and programs, and other compatible uses
- Preserve open space for future generations

5.2.3.3. City of Sunnyvale

Like Mountain View, the City of Sunnyvale considers parklands an essential component of a desirable urban environment and is committed to maintaining and improving its system of parks and open space. The Community Development Element of the Sunnyvale General Plan (City of Sunnyvale 1992) articulates six goals for open space in the city, as summarized below.

- Manage a comprehensive open-space program that is responsive to public need, delivers high-quality customer service, and exemplifies the city's commitment to leadership in environmental affairs
- Acquire and develop high-priority open space through land dedication or purchase
- Maintain a park system that ensures that all city residents, workers, and visitors have access to recreational opportunities by providing neighborhood parks, athletic/play fields, and special use facilities
- Cooperate with and support local school districts in providing city residents, workers, and visitors access to school sites and facilities for suitable, safe, and consistent recreational use
- Encourage and cooperate with other governmental agencies to preserve and protect regional open space and to acquire, develop, maintain, and operate regional recreational facilities that are available to city residents, workers, and visitors
- Encourage efforts by industrial and commercial enterprises to preserve, develop, operate, and maintain open space and recreational facilities that are available to city residents, workers, and visitors

5.3. REGIONAL SETTING

This section describes offsite recreational facilities in the vicinity, with a focus on facilities that are close enough to ARC that they are likely to be used by ARC employees, residents, and visitors. Westcoat/Berry Court Army housing complex has been privatized and new housing has been constructed. This development includes recreation facilities and green belt area.

- Shoreline at Mountain View Regional Park. Shoreline at Mountain View Regional Park is a 280-hectare (700-acre) regional recreation and wildlife area. It offers concert and event facilities, a network of hiking and biking trails, a restored Victorian home built by Henry Rengstorff in 1867, a championship golf course, a 20-hectare (50-acre) saltwater sailing lake, and a meadow area for picnics and play. It also includes natural areas that offer important habitat for wildlife and migratory birds.
- San Vernon Park. San Vernon Park has an area of 0.8 hectare (2 acres) and includes a basketball court, playground, picnic area, and outdoor volleyball court.
- Stevenson Park. Stevenson Park has an area of 5 hectares (12 acres) and offers a basketball court, playground, soccer/football field, picnic area, softball field, and tennis courts.
- Whisman Park. Whisman Park has an area of 5 hectares (12 acres) and offers a basketball court, playground, soccer/football field, softball field, tennis courts, barbeque facilities, outdoor volleyball court, and access to hiking trails.
- Baylands Preserve. Operated by the City of Palo Alto and bounded by Mountain View and East Palo Alto, the 785-hectare (1,940-acre) Baylands Preserve is the largest tract of undisturbed marshland in the Bay Area. It includes 24 kilometers (5 linear miles) of multiuse trails, the Lucy Evans Baylands Nature Interpretive Center, the Byxbee Park Hills Art Park, and picnic and barbecue facilities. Baylands Preserve is widely considered to offer some of the best bird-watching opportunities available in the Bay Area (DMJM 2002).
- Sunnyvale Municipal Golf Course. The Sunnyvale Municipal Golf Course offers 18 holes and has an extent of about 80 hectares (200 acres), of which 15 hectares (35 acres) are part of ARC.
- Baylands Park. Baylands Park offers more than 30 hectares (70 acres) of developed parkland that includes play areas, picnic areas, and the Baylands Grove Amphitheater. It also provides connections to the Bay Trail. An additional 40 hectares (105 acres) of seasonal wetland habitat is protected as a wetlands preserve.

- Stevens Creek Trail. Stevens Creek Trail is a heavily used feeder trail for the Bay Trail. It starts at Landels Park in Mountain View and follows Stevens Creek through urban residential neighborhoods and high-tech business parks to the Bay Trail. A portion of the Stevens Creek Trail follows the western edge of the ARC campus.
- Stevens Creek Shoreline Nature Study Area. The Stevens Creek Shoreline Nature Study Area is a nature preserve operated by the Midpeninsula Regional Open Space District. This area is part of the NASA Ames storm water retention pond complex and is accessed via a pedestrian bridge from Shoreline at Mountain View Regional Park.
- Bay Trail. The Bay Trail is planned as a multiuse recreational corridor offering 650 kilometers (400 continuous miles) of hiking and bicycling trails encircling San Francisco and San Pablo Bays. Insofar as possible, proposed Bay Trail alignments incorporate BCDC's public access trails, which were designed in accordance with the Bay Plan. To date, approximately 340 kilometers (210 miles) of the trail network have been completed, including segments at Baylands Park in Sunnyvale, Alviso Marina County Park in Alviso, and Shoreline at Mountain View Regional Park in Mountain View. A segment of the Bay Trail is planned to run through the northern portion and along the northern boundary of the ARC campus (See Figure 5-1). This segment has not yet been constructed, but is planned as one of early projects associated with the South bay Salt Pond Restoration Project.

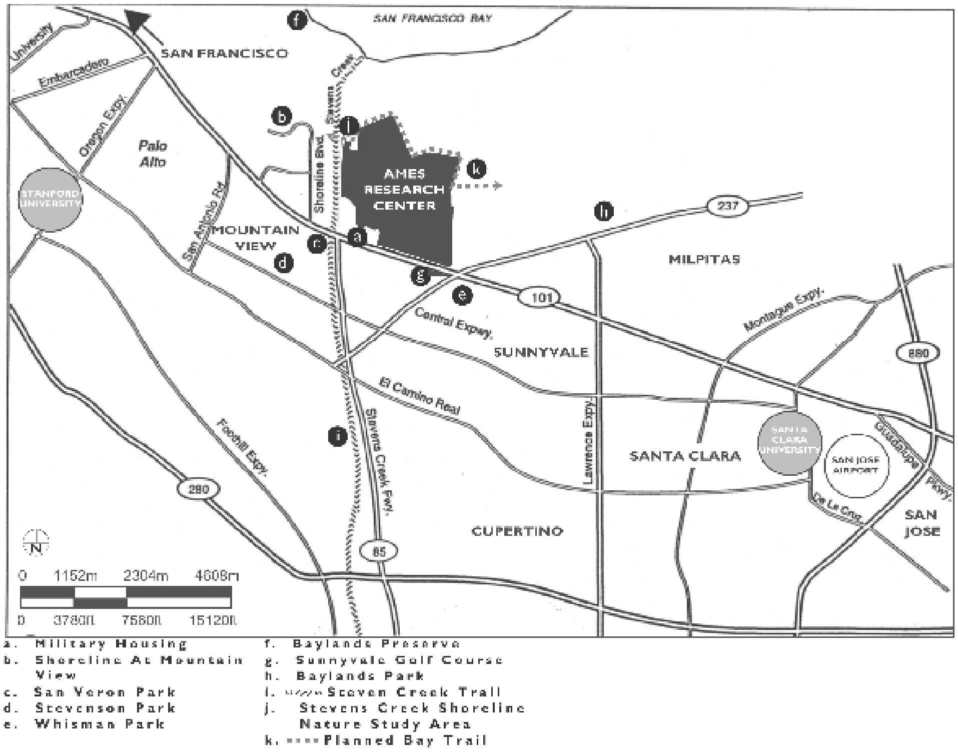

Figure 5-1 Recreational Facilities in the Vicinity

Don Edwards San Francisco Bay National Wildlife Refuge. Founded in 1974, Don Edwards San Francisco Bay National Wildlife Refuge was the first urban National Wildlife Refuge established in the United States (US Fish & Wildlife Service 2004.) Administered by US Fish & Wildlife Service (USFWS), the refuge encompasses 30,000 acre of open bay, salt pond, salt marsh, mudflat, upland and vernal pool habitats located throughout south San Francisco Bay (See Figure 5-1).

5.4. EXISTING SITE CONDITIONS

ARC offers a variety of recreational opportunities. The total area of recreational and open space areas on the ARC campus is approximately 215 hectares (535 acres). Of this, approximately 50 hectares (123 acres) support existing or planned active recreation facilities such as the following (see Figure 5-2).

- The 45-hectare (112-acre) golf course in the Eastside/Airfield area
- Playing fields
- The swimming pool

- Picnic grounds
- Volleyball courts
- Informal recreation areas
- Natural areas that are used for walking and trail running

An additional 170 hectares (425 acres) of undeveloped land in the Bay View and North of Bay View areas offer roads that are also used for walking and running. NASA's Bicycle Commute Trail (also used by pedestrians) extends from the Stevens Creek Trail to the Wright Avenue Gate (Gate 17).

5.5. ENVIRONMENTAL COMMITMENTS

NASA and ARC have identified the following environmental measures that are designed to address potential air quality effects of operations and future development at ARC and are implemented to the extent feasible.

5.5.1. MITIGATION MEASURES

The NASA Ames Development Plan (NADP) Final Programmatic Environmental Impact Statement (FEIS) identified the following mitigation measures to address potential recreation impacts from build out of Mitigated Alternative 5 in the NADP (Design, Community & Environment 2002). For a full discussion of impacts and mitigation measures related to the NADP, see the FEIS.

Chapter 6. Aesthetics

6.1. OVERVIEW

This chapter describes the visual character of ARC, the remaining areas of Moffett Field, the adjacent portions of the cities of Mountain View and Sunnyvale, and the views into and out of ARC. This chapter also includes a discussion of the regulatory framework and environmental measures that guide structural changes and development at ARC. The information presented in this chapter is based on the NASA Ames Development Plan Final Programmatic Environmental Impact Statement (Design, Community & Environment 2002).

6.2. REGULATORY REQUIREMENTS

Site and building design at ARC is guided by NASA's Design Guide for the NRP (NASA. 2001). The purpose of the Design Guide is to provide consistent direction for the integration of the Center's built environment, including site planning, planting, architecture, signage, lighting, roadways and other public works. The Design Guide establishes a framework that allows for the development of flexible creative solutions to address planning issues in manner that maintains the individual character of the various districts at ARC. The overall goal of the Design Guide is to foster a safe, functional, and attractive place in which to live and work.

In addition to general planning concepts concerning open space, circulation, and infrastructure, the Design Guide includes numerous design concepts

Currently, there are no design guidelines, height limits, and setback requirements for the Bay View, Ames Campus, and Eastside/Airfield areas. Potential tenant is developing design guidelines.

6.2.1. SANTA CLARA COUNTY TREE PRESERVATION AND REMOVAL ORDINANCE

Santa Clara County's Tree Preservation and Removal Ordinance (County Code Division C16) was adopted to establish and maintain tree cover, protect property values, preserve aesthetic resources, prevent erosion, counteract air pollution, provide wind protection, maintain climatic balance, provide habitat, and to protect community and historic assets. The ordinance protects all qualified trees on both public and private land. Any tree that qualifies as a protected tree may not be removed without having first obtained a permit unless it is irreversibly diseased or dead, or if it represents a hazard. In order to obtain a permit, the applicant must submit plans that include a plan to replant trees of similar types, including native trees where the protected tree to be removed is a native (Santa Clara County Ordinance No. NS-1203.107, §1, 2-11-97).

6.3. REGIONAL SETTING

ARC is located along the southwestern edge of the San Francisco Bay in the northern portion of Santa Clara County, California (Figure 1-1). The City of Mountain View borders the center to the south and west, and the City of Sunnyvale borders it to the south and east (Figure 1-2).

6.4. EXISTING SITE CONDITIONS

This section describes the aesthetic character of ARC and the areas of Moffett Field not under NASA administration, and the adjacent portions of the cities of Mountain View and Sunnyvale. These areas have been divided into multiple visual units that correspond to the locations identified on Figure 6-1, Location of Visual Unit.[1]

Figure 6-1 Location of Visual Units

6.4.1. VISUAL CHARACTER OF THE SURROUNDING AREA

This section describes the current visual character of the areas surrounding ARC in the cities of Mountain View and Sunnyvale. See Figure 6-1 for the location of specific visual units.

[1] Numbering of visual units in this document corresponds to numbering of visual units in the NASA Ames Development Plan Final Programmatic Environmental Impact Statement (Design, Community & Environment 2002).

6.4.1.1. Undeveloped Land to the West (Visual Unit 17)

Immediately to the west of ARC is Stevens Creek. Stevens Creek is bordered by tall, mostly unvegetated earthen levees. A narrow asphalt recreational trail runs along the top of the western levy. Toward the center of ARC's boundary, a long, narrow Christmas tree farm abuts the creek. Together, the creek and the tree farm create a natural/agricultural buffer zone between ARC and Mountain View, as shown in Figure 6-2.

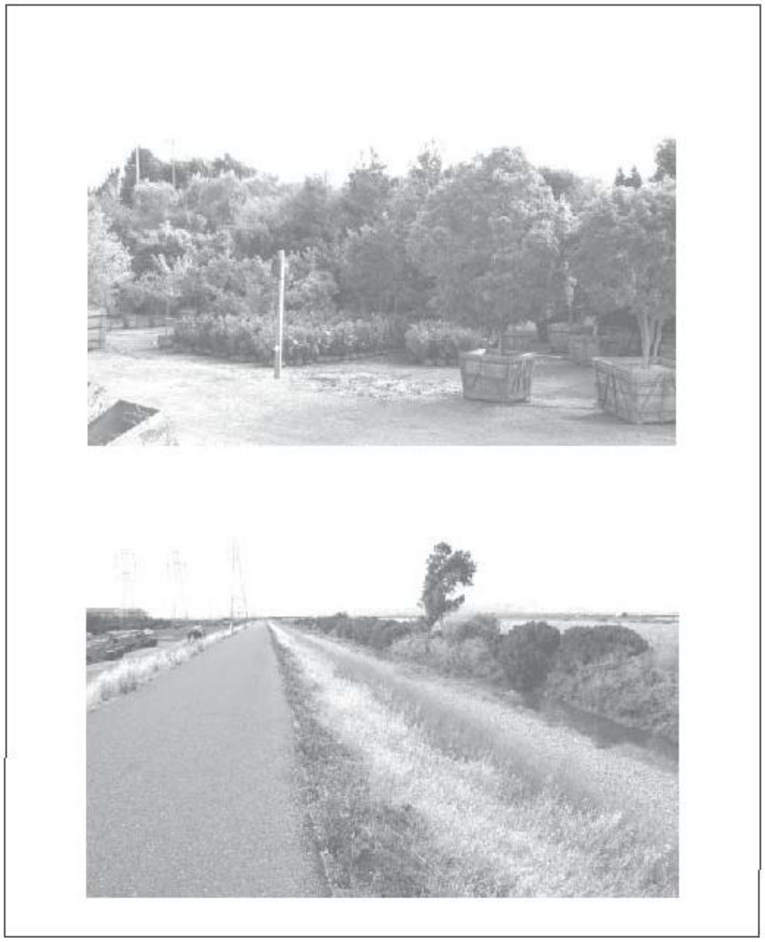

Figure 6-2 Visual Unit 17. Undeveloped Land to the West

6.4.1.2. Office/Industrial Park to the Northwest (Visual Unit 18)

Beyond the natural buffer strip in Visual Unit 17 is an office and light-industrial development characterized by predominantly two-story buildings in a mix of architectural styles, as shown in Figure 6-3. Most of the buildings are constructed of concrete, although there are a number of brick buildings and a few buildings faced with wood. In most cases, buildings are set back with parking lots adjacent to the street. Main building entrances are located generally away from these lots rather than facing the street. Most of the buildings date from the 1970s and 1980s, though there are some large new complexes of two- to three-story postmodern buildings, especially along Shoreline Boulevard and L'Avenida. Very little vacant land remains within the current boundaries of the developed area, and the large open tracts in the eastern section are currently being developed. Exterior wall and roof colors are generally neutral, though most of the new buildings have brightly colored accents.

Within this office/light-industrial visual unit, streets are landscaped, often with mature trees, and minor landscaping around buildings and within larger parking lots is common. Most of the area is visually shielded from ARC by a hedgerow of tall, bushy oleander and other similar plants.

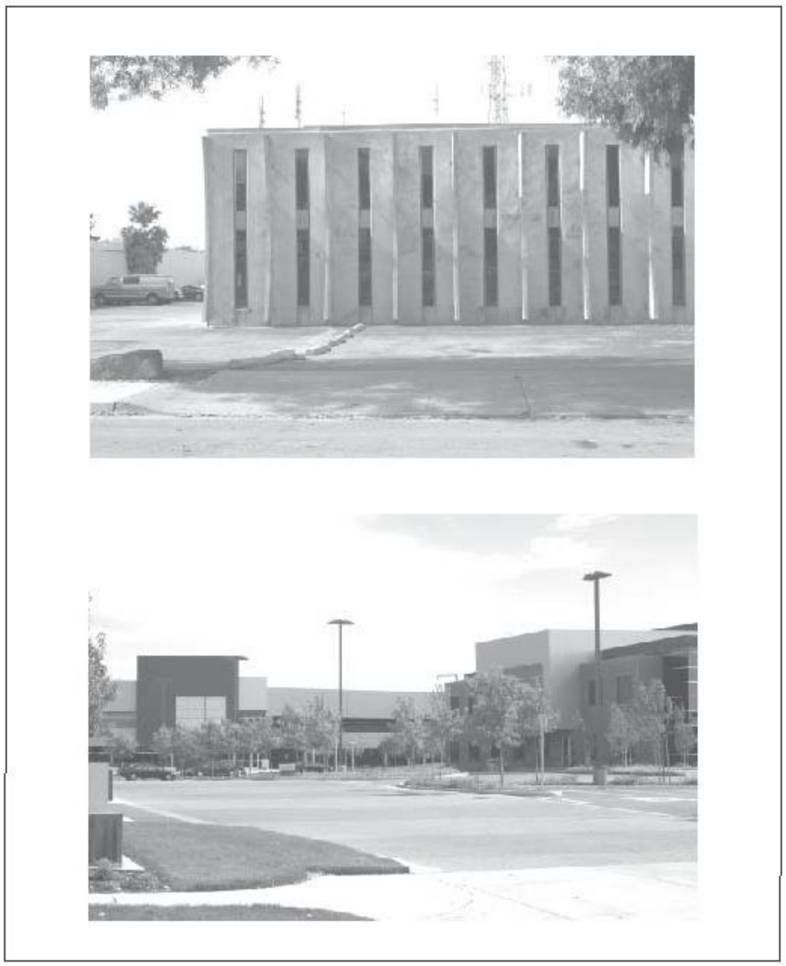

Figure 6-3 Visual Unit 18 Offices/Industrial Park to the Northwest

6.4.1.3. Mobile Home Park to the West (Visual Unit 19)

Toward the southern edge of the office/industrial area is a densely settled mobile home park with more than 350 homes on 15 hectares (37 acres), as shown in Figure 6-4. With a single exception, all of the homes are one-story and access roads are quite narrow. Some small-scale landscaping exists around individual units, and large palm trees at a few intersections. A dense oleander hedge borders the entire development.

Figure 6-4 Visual Unit 19 Mobile Home Park to the West

6.4.1.4. North to San Francisco Bay (Visual Unit 20)

To the north, ARC is bordered by the extensive open expanse of the former Cargill Salt Ponds, now USFSW refuge lands. To the northwest is Mountain View Shoreline Park. A strip of U.S. Fish and Wildlife Service Preserve also extends northeast from the end of the eastern airstrip.

6.4.1.5. The Lockheed Martin Complex (Visual Unit 21)

To the east, the Lockheed Martin Complex borders ARC. Views are shown in Figure 6-5. This sprawling complex of office and heavy industrial buildings includes a wide variety of architectural styles, most of them quite plain and industrial in appearance. Heights vary from one to four stories. Large areas of the complex are fenced off for security purposes, and "no-trespassing signs" are prominently visible at all entrances. Large surface parking lots with minimal landscaping surround all the buildings. There are a few streets with trees, but no consistent pattern of vegetation. Moffett Towers, a group of high-rise glass exterior business offices has been constructed on the Lockheed site.

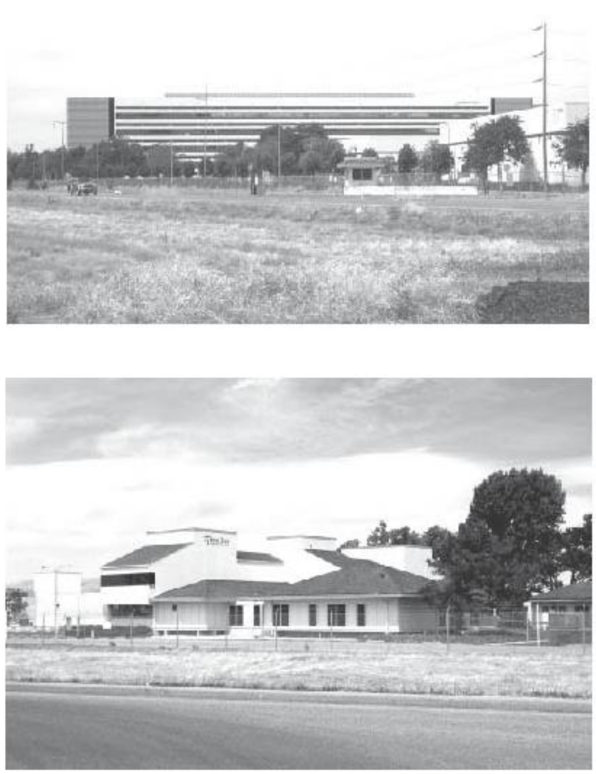

Figure 6-5 Visual Unit 21. The Lockheed Martin Complex

6.4.1.6. Residential Neighborhood across U.S. Highway 101 (Visual Unit 22)

U.S. Highway 101 is a formidable visual and physical barrier between ARC and the areas on the south side of the freeway. Views of the neighborhood and the sound wall are shown in Figure 6-6. The freeway is eight lanes wide in this area, and is bordered on the western end of ARC's southern edge by sound barriers on both sides. There are a number of different uses across Highway 101 in Mountain View and Sunnyvale. To the southwest is an older residential neighborhood with a variety of housing types ranging from multi-family two-story apartment complexes to duplexes to small, one-story detached single-family homes. Within the heart of the residential neighborhood, streets are wide with narrow sidewalks and mature trees on the front lawns of the houses.

Figure 6-6 Visual Unit 22. Residential Neighborhood Across Highway 101

6.4.1.7. Mixed-Use Strip across U.S. Highway 101 (Visual Unit 23)

Along U.S. Highway 101 and Moffett Boulevard, a mixed-use strip that includes motels, restaurants, a mobile home park, a bar, and a gas station, as shown in Figure 6-7 borders the residential area described in Visual Unit 22. These commercial buildings are one to two stories tall in a variety of architectural styles. Many of the buildings are set back from the street with small parking lots in front.

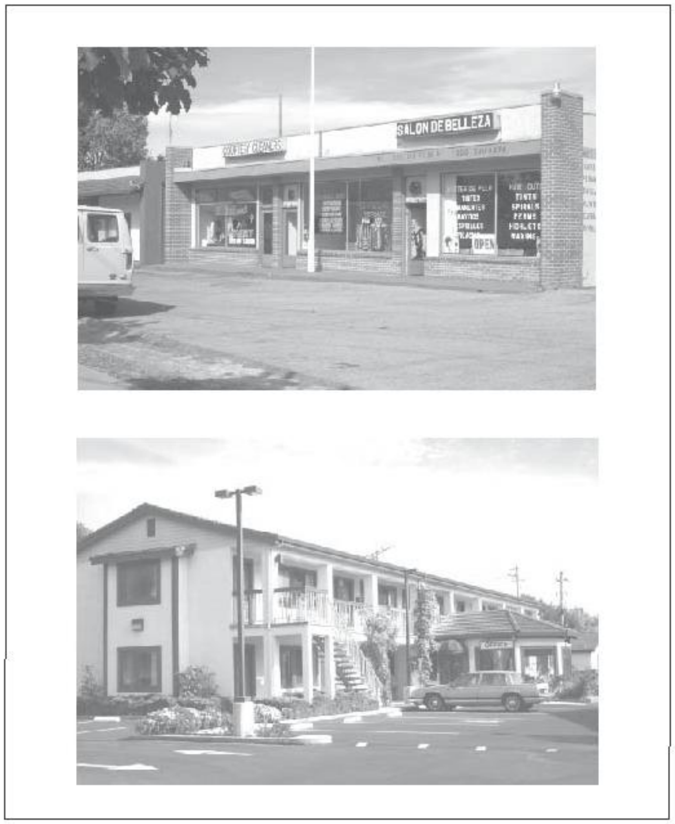

Figure 6-7 Visual Unit 23. Mixed-Use Strip Across Highway 101

6.4.1.8. Whisman Industrial Area across U.S. Highway 101 (Visual Unit 24)

Directly south of ARC in the area bordered by Middlefield, Ellis, and Whisman streets is an expansive office and industrial park area, as shown in Figure 6-8. A variety of buildings are contained within this visual unit. These include a few older, one-story industrial buildings near the center of the area, set back from the street with mature trees along their street frontages. The majority of the unit, however, is split between two large new office developments that have Netscape and Nokia as their primary tenants. The new buildings are faced with textured concrete with some detailing on facades and recessed windows and entrances. Most of these buildings are two stories high, although some reach three stories. They are all dark beige in color, with low-pitched red-tile roofs that give them a touch of Spanish Colonial Revival style. Parking is in large linear lots with generous but immature landscaping. The distinctive slender peaked towers of the treatment stations for the contaminated groundwater that underlies this entire area punctuate each of the lots. Part of the land within this visual unit is vacant.

Figure 6-8 Visual Unit 24. Whisman Industrial Area Across Highway 101

6.4.1.9. The Sunnyvale Municipal Golf Course (Visual Unit 25)

The Sunnyvale Municipal Golf Course, 14 hectares (35 acres) of which belong to ARC, is located to the southeast of ARC. Views are shown in Figure 6-9. This large green space provides a counterpoint to the development that surrounds it.

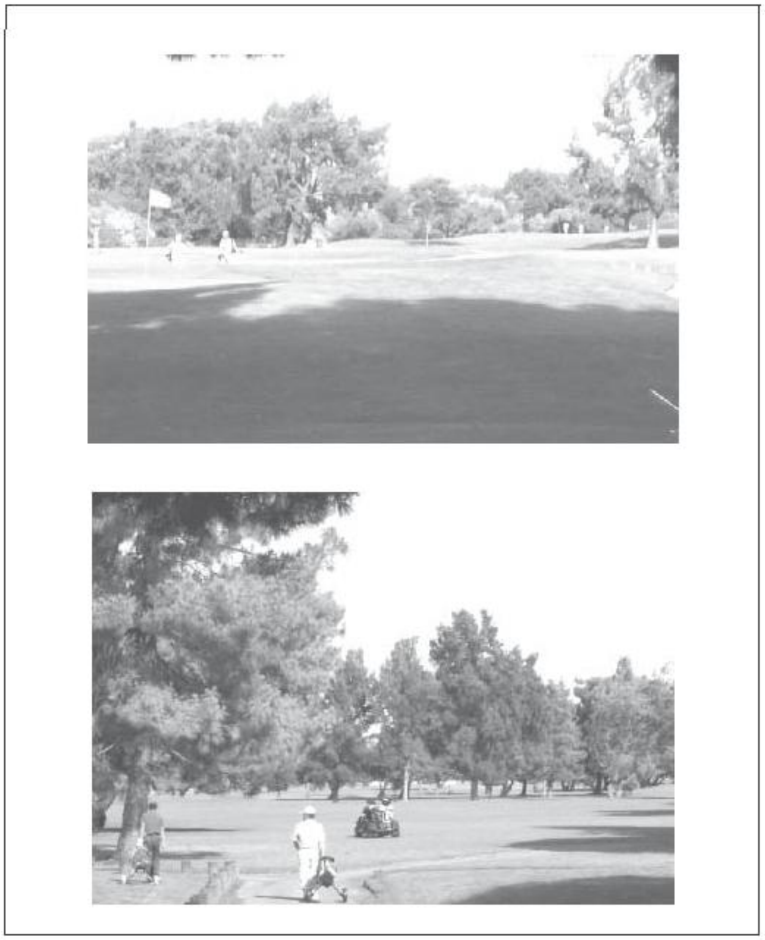

Figure 6-9 Visual Unit 25. The Sunnyvale Municipal Golf Course

6.4.2. VIEWS INTO THE NASA AMES RESEARCH CENTER

The essentially flat topography of ARC extends for miles around, so none of the areas abutting the center has a clear view of the facilities. Landscaping and development almost always obstruct lines of site into ARC. Only the tallest features are visible, even from the frontage road just across U.S. Highway 101.

Of the features visible from outside ARC, by far the most striking are the towering parabolic forms of the airship hangars, each of which is nine stories tall and encloses approximately 3 hectares (8 acres) of land. Hangar 1, the first hangar at Moffett Field, was completed in 1933 to house the dirigible named USS Macon. It is the primary landmark within ARC and the most visible part of it from the north and west. Hangars 2 and 3, on the opposite side of the airfield, were constructed during World War II to house the revitalized Naval lighter-than-air program. They stand out strongly against the diked ponds that slope down to the Bay, and are especially visible from the Lockheed Martin complex and the eastern side of ARC. The soaring forms of the three hangars against the backdrop of the Bay have made Moffett Field one of the most distinctive landscapes in the Bay Area for more than 60 years.

The wind tunnels are the other feature of ARC visible for long distances. Given their placement on the site, they are most visible from the northwest, although it is possible to get occasional glimpses of them from the residential neighborhood to the southwest of Moffett Field across U.S. Highway 101.

All of these features are visible from a distance from parts of the coastal hills to the west, the East Bay hills to the east, and the Mount Hamilton Range to the south.

6.4.3. VISUAL CHARACTER OF NASA AMES RESEARCH CENTER

This section describes the existing visual character of each of the four planning areas within ARC. These planning areas include the NASA Research Park area, Ames Campus area, Bay View and North Bay View, and Eastside/Airfield. The area north of Bay View is also described below.

6.4.3.1. NASA Research Park Area

The NASA Research Park area is roughly triangular, and can be divided into a number of distinct visual units, each with its own character, landscaping, and typical uses. The discussion that follows describes each of these units individually. Figure 6-1 shows the location of the visual units within the NASA Research Park.

Western End of Shenandoah Plaza (Visual Unit 1)

The original plan for Shenandoah Plaza is clearly discernible and largely unchanged in this unit. Views are shown in Figure 6-10. The street grid still outlines a generous horseshoe-shaped central lawn surrounded by attractive historic Spanish Colonial Revival buildings, with their characteristic plain stucco walls, low-pitched red-tile roofs, and terra cotta ornamentation. The formal axis of the lawn sweeps eastward unchecked to the former administration building, pointing toward the immense streamlined form of Hangar 1. In addition to the lawn, the original design's rows of mature liquid amber trees have been preserved, and these two landscape elements combine to give the western end of Shenandoah Plaza a formal, park-like feel quite distinct from the surrounding landscape.

Figure 6-10 Visual Unit 1. Western End of Shenandoah Plaza

Eastern End of Shenandoah Plaza (Visual Unit 2)

In the eastern half of the Shenandoah Plaza area, the original site plan is much less clear. Views are shown in Figure 6-11. This area was originally designated as the industrial area of Shenandoah Plaza. Although historic original Spanish Colonial Revival structures remain, a large number of infill structures have been built in the stretch of land between the western end of Shenandoah Plaza and Hangar 1. These infill buildings are generally unobtrusive, but they are much smaller than the original buildings. They are predominantly used for storage and light industrial uses, and so are much more utilitarian in design than the historic structures. They are also placed more closely together. There are only minimal trees and landscaping in this unit. There is a small monument and plaza west of Building 3; the only other open spaces are a number of medium-sized parking lots.

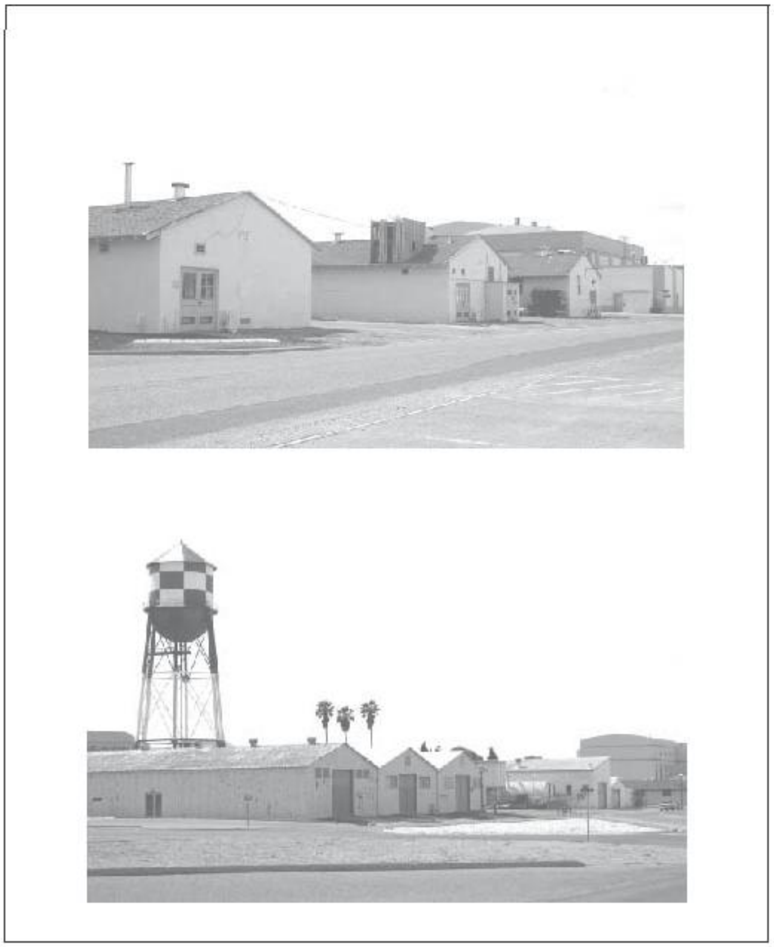

Figure 6-11 Visual Unit 2. Eastern End of Shenandoah Plaza

Southeastern Perimeter of the NASA Research Park Area (Visual Unit 3)

The outer perimeter of the southern part of the NASA Research Park area, as shown in Figure 6-12, is characterized by sizeable open areas: the undeveloped land alongside the airfield that supports a small burrowing owl population; the undeveloped land between Cody Road and the new light rail station; the open expanse of asphalt of the California Air National Guard motorpool lot; and the broad turf area of the athletic fields that abut U.S. Highway 101. Unlike in Shenandoah Plaza, these open spaces are not formally landscaped, nor are they the central organizing features of the built environment around them. They do contribute to the NASA Research Park area's less built-up feel, and allow views east to the hangars and west to the coastal hills. The California Air National Guard motor pool lot and the recreation area adjacent to Highway 101 are planned for development.

Figure 6-12 Visual Unit 3. Southeastern Perimeter of the NASA Research Park Area

The Barracks (Visual Unit 4)

A roughly "L"-shaped group of former barracks that is characterized by a dense clustering of bar-shaped buildings makes up the fourth visual unit in the NASA Research Park area. Typical barracks are shown in Figure 6-13. The 129th Army Reserve Command occupies the southern four buildings, while the northern four buildings are empty. The line of barracks that runs north-south is two stories tall and covered with white stucco. The buildings along the east-west arm of the "L" are three-story, gray concrete block structures with access from an outside corridor that runs the length of each building on each floor. These buildings are normally used as short-term housing for students, reservists, and visitors. Both sets of buildings are typical of the plain, functional style characteristic of most military architecture. Each of the barracks buildings is surrounded by open lawn. Streets and parking lots in this visual unit are edged with mature trees.

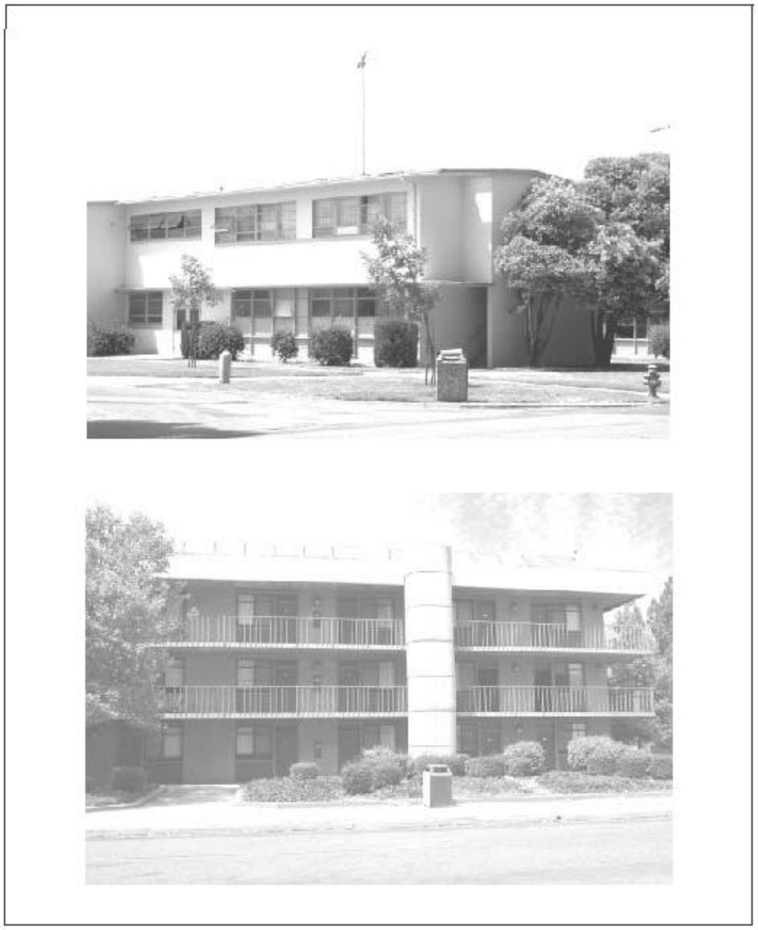

Figure 6-13 Visual Unit 4. The Barracks

Exchange Area (Visual Unit 5)

The various buildings are associated with the Defense Commissary Agency (DECA). The Commissary and the Navy Exchange are large, plain, architecturally undistinguished one-story buildings. Each is surrounded by a large parking lot with no internal landscaping, as shown in Figure 6-14. There are no historic buildings in this unit, and very little landscaping. Some undeveloped land remains, but most open space is covered in asphalt.

Figure 6-14 Visual Unit 5. Exchange Area

Main Entry (Visual Unit 6)

With the exception of the historic gate house and iron fence, all of the buildings within this unit are modern and do not contribute to the Shenandoah Plaza Historic District, as shown in Figure 6-15. Much of this unit consists of the Visitor Space Exploration Facility, most of which is cut off from the rest of ARC by a tall fence. Within this area buildings are typically one-story high and clad in white metal with blue accenting. There is no significant landscaping within this visual unit.

Figure 6-15 Visual Unit 6. Main Entry

6.4.3.2. Ames Campus Area (Visual Unit 7)

To the northwest of the NASA Research Park area is the Ames Campus area, NASA's original base of operations at Moffett Field. Views are shown in Figure 6-16. The Ames Campus area is densely developed with almost 100 laboratory and office buildings on 95 hectares (234 acres) of land. Most of the buildings are utilitarian, unpainted concrete office and lab buildings constructed in the 1940s and 1950s. The majority of these buildings are two stories tall, though there are a few one-story structures and a smaller number of taller three- to four-story buildings. In addition to the concrete structures, numerous temporary trailers house offices. Perhaps the most striking features of the built landscape within the Ames Campus area are the wind tunnel complexes, some of which tower up to 25 meters (80 feet) above the ground. Their gigantic, unusual shapes give a distinctly industrial feel and an entirely different scale to this visual unit. Within the Ames Campus area, streets are generally wide with generous planting strips on each side and allées of mature street trees, often plane trees. Parking lots are generally narrow and skirt the edges of buildings. Where larger parking lots occur, there is significant interior landscaping.

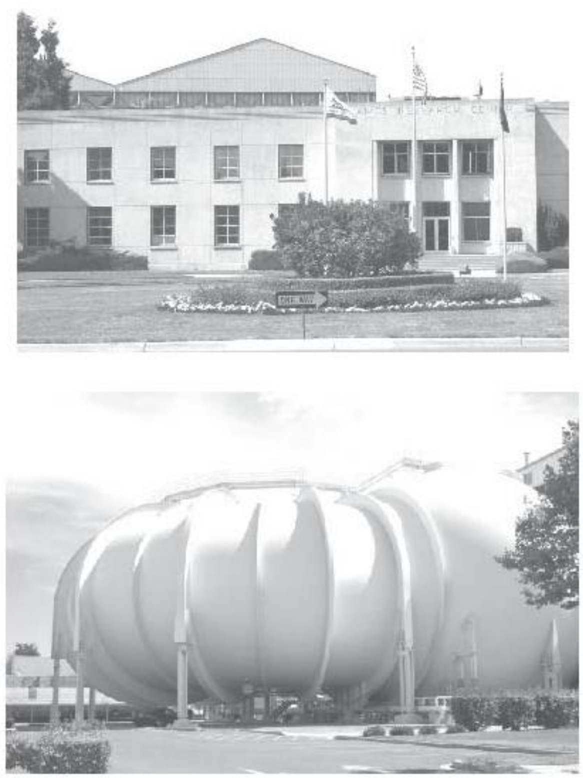

Figure 6-16 Visual Unit 7. Ames Campus Area

6.4.3.3. Bay View and North of Bay View (Visual Unit 8)

Visual Unit 8 sits within the 100-year floodplain and is almost entirely undeveloped. Facilities here are limited to the 12-meter (40-foot)-tall steel frame of the Outdoor Aerodynamic Research Facility and a few small one- or two-story concrete structures housing telecommunications equipment. Views are shown in Figure 6-17. The southern portion of the visual unit is undeveloped upland grassland habitat with a small amount of seasonal wetlands skirted by 4-meter (12-foot)-high earthen berms along Stevens Creek to the west and the airfield to the east. The northern portion of Visual Unit 8 consists of the Eastern and Western Diked Marshes, low open areas of wetlands bordered by roads. The dominant features of this visual unit are the expanse of low vegetation, and views across it to the development off Shoreline Drive in Mountain View, the Ames Campus area, and the airfield.

Figure 6-17 Visual Unit 8. Bay View and North of Bay View

6.4.3.4. Stormwater Retention Pond (Visual Unit 9)

Visual Unit 9 is located northwest of the airfield and north of the diked marshes. Views are shown in Figure 6-18. North Perimeter Road and the security fence divide views from the latter. There are a few small structures along the southern edge, but the main features of this visual unit are a border of upland vegetation along North Perimeter Road and wide expanses of water in the stormwater retention pond, the western portion of which is owned by the Midpeninsula Regional Open Space District. There are also views across the road and pond to the East Bay Hills.

Figure 6-18 Visual Unit 9. Stormwater Retention Pond

6.4.3.5. Eastside/Airfield

This section describes the current visual character of the Eastside/Airfield development area. The Eastside/Airfield area is roughly triangular and is bordered by the airfield to the west, the Lockheed Martin complex to the east, and the former Cargill Salt Ponds to the north.

The Airfield (Visual Unit 10)

The airfield is an open expanse of concrete and grass median strips consisting of the airfield and the undeveloped land adjacent to its southern end, as shown in Figure 6-19. The two runways are 60 meters (200 feet) wide, and 2,800 meters (9,200 feet) and 2,500 meters (8,100 feet) long, respectively. The airfield divides the built-up western portion of ARC from the far less developed northeastern portion, and allows expansive views across ARC to Hangars 2 and 3 and the San Francisco Bay.

Figure 6-19 Visual Unit 10. The Airfield

California Air National Guard Area (Visual Unit 11)

The California Air National Guard area (shown in Figure 6-20) is roughly triangular in shape, with its two long sides delineated by Macon Road and the Lockheed Martin complex to the east, and East Patrol Road to the northeast. The short, southern end of the triangle runs roughly parallel to the end of the runways. The area has buildings with adjacent land adequate for California Air National Guard to consolidate and construct mission essential facilities. Trees are numerous on the land, grass areas are sprinkled, medians have been landscaped, and land awaiting development has been left in its natural form. Open land is either airfield safety zones, identified for future facilities, burrowing owls, recreation, or restricted areas necessary to maintain security.

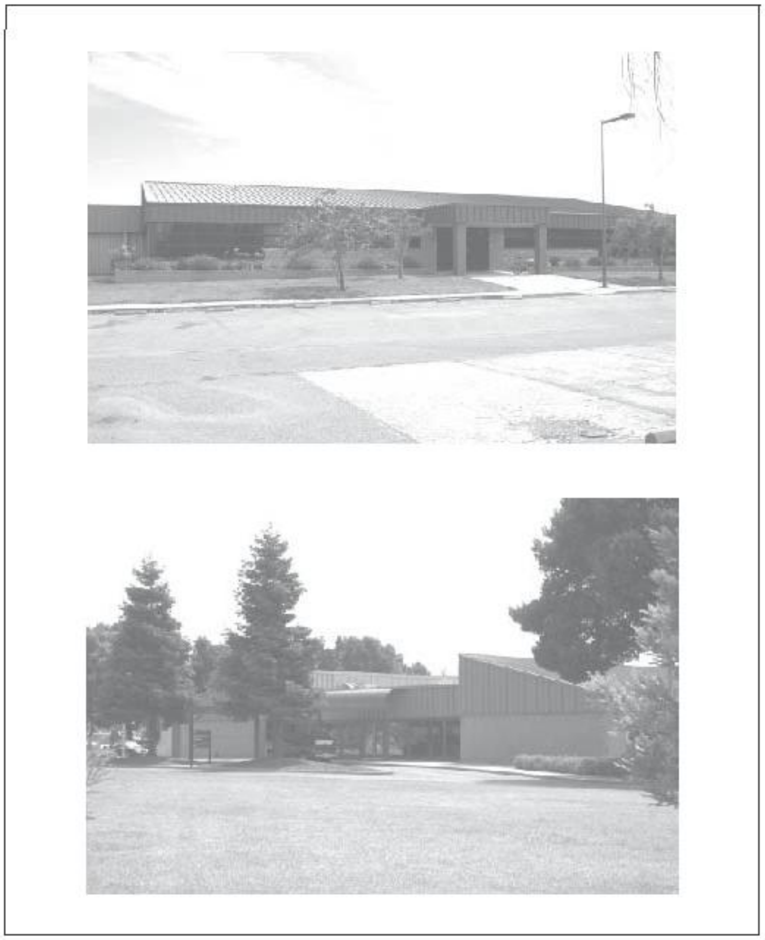

Figure 6-20 Visual Unit 11. California Air National Guard Area

Hangars 2 and 3 (Visual Unit 12)

The hangar area is bordered by the California Air National Guard area to the south, Macon Road to the east and north, and the airfield to the west. It is almost entirely paved, and the dominant visual feature is the elegant parabolic form of the two historic hangars, as shown in Figure 6-21. There are also a number of small, architecturally undistinguished buildings housing maintenance and repair facilities. There are usually a number of military planes and helicopters on the pavement adjacent to the hangars.

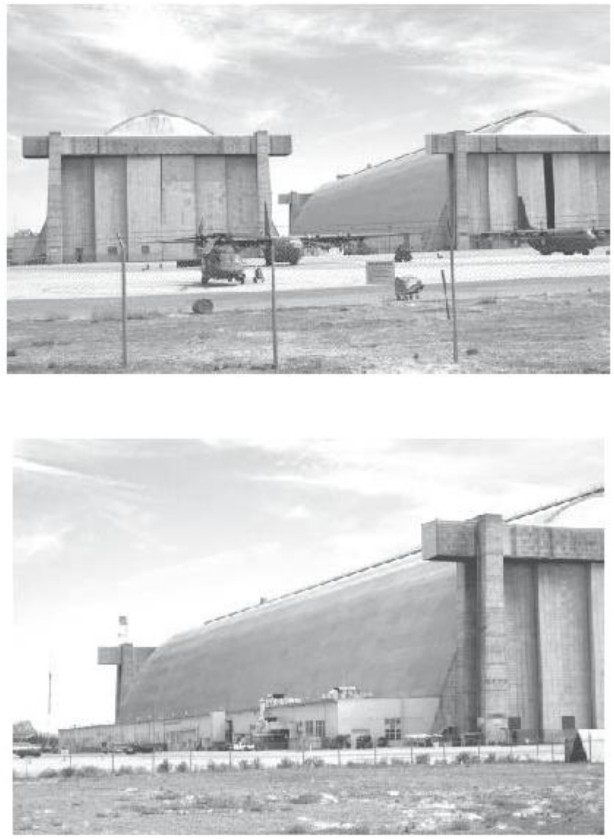

Figure 6-21 Visual Unit 12. Hangars 2 and 3

The Golf Course and Munitions Bunkers (Visual Unit 13)

East Patrol Road to the southeast, the USFWS ponds to the north, and the airfield and hangar areas to the west border the golf course. Views are shown in Figure 6-22. The tree-lined fairways of the golf course and raised mounds of the munitions bunkers characterize the area. It is also home to a second parking area for recreational vehicles, and an electrical station. The golf course is skirted by undeveloped ruderal land.

Figure 6-22 Visual Unit 13. The Golf Course and Munitions Bunkers

6.4.4. VISUAL CHARACTER OF THE REMAINDER OF MOFFETT FIELD

This section describes the visual character of the areas of Moffett Field not under NASA administration, and thus outside ARC: the Berry Court and Orion Park military housing areas.

6.4.4.1. Berry Court Military Housing Area (Visual Unit 14)

The Berry Court Military Housing area is tucked into a roughly triangular area between the barracks area, U.S. Highway 101, and the U.S. Space Camp compound. Views are shown in Figure 6-23. The Berry Court Military Housing area has three distinct neighborhoods. The westernmost area consists of two-story wooden duplexes with attached carports. Exterior walls are painted white and are not ornamented. Roofs are low-pitched with reddish-brown shingles. Groups of three duplexes are clustered onto "U"-shaped courts that extend off the central curvilinear road, which ends in a cul-de-sac. Each building is surrounded by open expanses of lawn, the primary feature of the landscape. There are also a few mature trees in front of each building.

The central housing area, Berry Court, is part of the Shenandoah Plaza Historic District. These nine Spanish Colonial Revival residences are military officers' housing. All exterior walls are stucco-painted dark beige. There is minimal ornamentation around doors and windows; the buildings are quite plain. Roofs are low-pitched and covered in red tiles. Each house has an enclosed garage connected by an arcaded breezeway. Houses are placed symmetrically along a curvilinear road that ends in a large cul-de-sac with a broad oval green at its center.

The easternmost housing area is much larger than the other two. Here, white two-story wooden buildings are divided into fourplexes with shared carports. Each unit has its own front patio with a wooden fence shielding it from view. Again, buildings are arranged in clusters off a central, curvilinear road. Instead of ending in a cul-de-sac, the main road continues to connect to South Perimeter Road and the southern edge of ARC.

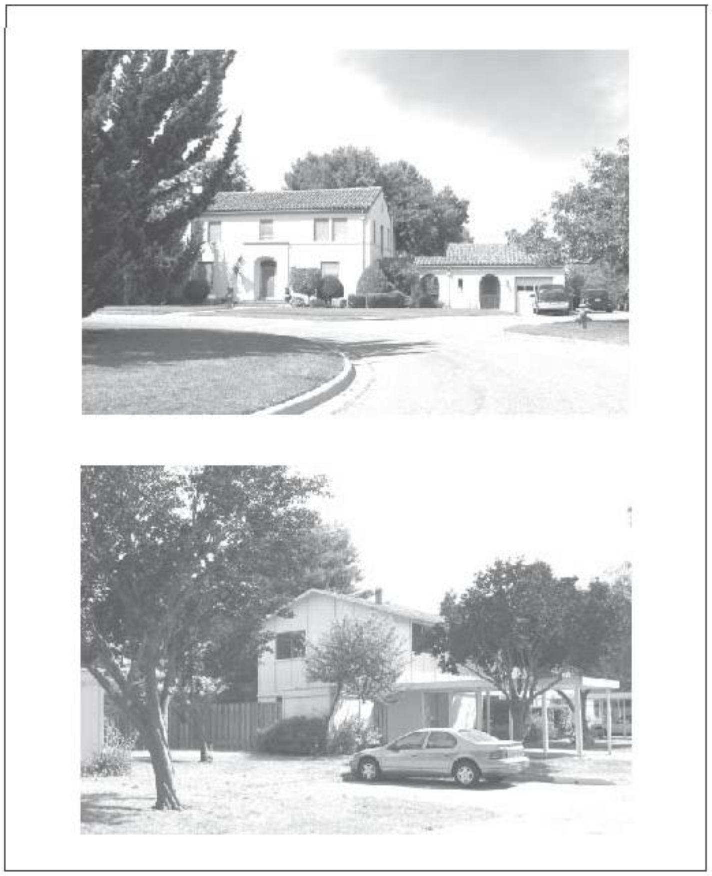

Figure 6-23 Visual Unit 14. Berry Court Military Housing Area

6.4.4.2. The Orion Park Military Housing Area (Visual Unit 15)

This complex has been demolished and the property will be used to accommodate the US Army Ready Reserve Sustainability Center, and the Headquarters building.

6.4.4.3. Military Office and Hotel Buildings (Visual Unit 16)

The final area in this visual unit is made up of military-associated uses: the Navy Lodge, the San Jose Military Processing Center, and the offices of the 129th Medical Squadron. Views are shown in Figure 6-24. This area resembles Visual Unit 5, with isolated buildings set in large parking lots. The buildings are plain stucco and concrete aggregate, and their primary decoration comes from banks of windows, which accent the buildings' vertical or horizontal character.

Figure 6-24 Visual Unit 16. Military Office and Hotel Buildings

6.4.5. PROTECTED TREES

To establish which trees at ARC qualify as protected trees under Santa Clara County's Heritage Tree Ordinance, NASA surveyed the entire ARC during summer 2001. The Berry Court and Orion Park military housing areas were not surveyed because they are not under NASA control. The survey identified trees in all of the planning areas except the Bay View area.

6.4.5.1. Ames Campus Area

In the Ames Campus area, protected trees are primarily located along streets or in planting strips in parking lots. Some areas house trees planted alongside existing buildings. Finally, there are a small number of protected trees clustered in the undeveloped area south of the administration building.

6.4.5.2. NASA Research Park Area

Within the NASA Research Park (NRP) area, the location of protected trees is not as regular as in the Ames Campus area. Within the Shenandoah Plaza Historic District, there are comparatively few protected trees, which for the most part are clustered in open space areas or grouped near buildings. The only areas where trees line a roadway are along Clark Memorial Drive, the entrance road, and a small strip along South Akron Road in front of Building 20. In the remainder of the NRP area, protected trees primarily line the edges of roads and parking lots, or are clustered around buildings. There are a few open areas adjacent to the athletic fields along U.S. Highway 101 and next to the Navy Exchange, where trees are more loosely grouped.

6.4.5.3. Eastside/Airfield Area

In the Eastside/Airfield area, protected trees are limited to the golf course, and the southernmost of the areas currently occupied by the California Air National Guard.

6.5. ENVIRONMENTAL MEASURES

NASA and ARC have identified the following environmental measures that are designed to address potential visual effects of operations and future development at ARC and are implemented to the extent feasible.

6.5.1. TREE REMOVAL

NASA is a federal agency and thus is not subject to the Santa Clara County's Tree Preservation and Removal Ordinance. However, ARC has agreed to comply with this ordinance wherever possible.

6.5.2. DESIGN GUIDELINES

To ensure harmonious design of future development at ARC, NASA will develop design guidelines for the Bay View, Ames Campus, and Eastside/Airfield areas to ensure that new buildings would stylistically complement the existing buildings in the Ames Campus and Eastside/Airfield. Design guidelines for the Bay View area would include setback requirements for Stevens Creek and the Western Diked Marsh.

Where new development may conflict with existing views or visual character, ARC plans to minimize visual conflicts with a combination of landscaping, screening, overall design, and siting of new structures. In particular, new development would be sited to best preserve existing view corridors across ARC, into the wetlands and salt ponds, and to San Francisco Bay.

6.5.3. MITIGATION MEASURES

The NASA Ames Development Plan (NADP) Final Programmatic Environmental Impact Statement (FEIS) identified the following mitigation measures to address potential visual impacts from build out of Mitigated Alternative 5 in the NADP (Design, Community & Environment 2002). For a full discussion of impacts and mitigation measures related to the NADP, see the FEIS.

Mitigation Measures

- Preserve view corridors
- Re-Plant protected trees, if removed
- Plant with native vegetation

Chapter 7. Cultural Resources

7.1. OVERVIEW

This chapter summarizes the regulatory framework relevant to cultural resources at ARC. It also discusses the prehistoric and historic setting of the ARC facility and describes the archaeological and historic resources that remain on the site. Environmental measures related to cultural resources are described in Section 7.5, Environmental Measures.

Some information presented in Section 8.4.2, Historic Resources, was obtained from the NASA Ames Development Plan Final Programmatic Environmental Impact Statement (Design, Community & Environment 2002).

7.2. REGULATORY REQUIREMENTS

The following federal and state laws and regulations that govern historic and archaeological resources apply to ARC.

7.2.1. FEDERAL LAWS AND REGULATIONS

7.2.1.1. Section 106 of the National Historic Preservation Act of 1966

Section 106 of the National Historic Preservation Act of 1966, as amended (16 USC 470) and 36 CFR 800 require that projects receiving federal money, or those permitted or licensed by federal agencies, must take into account the effects of the undertaking on historic properties, consult with the State Historic Preservation Officer (SHPO) regarding those effects, and allow the Advisory Council on Historic Preservation an opportunity to comment on the undertaking. Regulations implementing Section 106 encourage that consultation be completed in parallel with the NEPA compliance process.

Section 106 defines a *historic property* or *historic resource* as "any prehistoric or historic district, site, building, structure, or object included on, or eligible for inclusion" on the National Register of Historic Places (NRHP).

7.2.1.2. The Archaeological and Historic Preservation Act of 1974

The Archaeological and Historic Preservation Act of 1974 (16 USC 469) provides for "…the preservation of historical and archaeological data … which might otherwise be irreparably lost or destroyed as the result of … any alteration of the terrain caused as a result of any federal construction project or federally licensed activity or program." The act addresses actions that federal agencies are required or encouraged to take concerning proposed projects.

7.2.1.3. Native American Graves and Protection and Repatriation Act of 1990

The Native American Graves and Protection and Repatriation Act of 1990 (NAGPRA) (Title 25, United States Code [USC], Section 3001 et seq.) requires federal agencies and federally funded projects to document Native American human remains and cultural items within their collections, notify Native American groups of these items, and provide an opportunity for repatriation of these materials. It also requires plans for dealing with potential future collections of Native American human remains and associated funerary objects, sacred objects, and objects of cultural patrimony discovered as a result of projects funded or overseen by the federal government.

7.2.1.4. Historic Resources Protection Plan

NASA has prepared a Historic Resources Protection Plan (HRPP) for the Shenandoah Plaza Historic District. Section 7.4.2.1 has a description of the Shenandoah Plaza Historic District and associated resources. Among the objectives of the HRPP is to provide for the protection and treatment of historic properties by establishing guidelines for new construction within the Shenandoah Plaza Historic District and for the repair, maintenance, rehabilitation, alteration, reuse, and leasing of historic resources within the district. The HRPP establishes criteria and guidelines for the ongoing preservation and maintenance of historic resources within the Shenandoah Plaza Historic District.

7.3. REGIONAL PREHISTORIC AND HISTORIC SETTING

7.3.1. SETTING

Archaeological research suggests that the southern shore of the San Francisco Bay has been inhabited continuously for up to 4,000 years. At the time of European contact, the Costanoans (from the Spanish Costanos or "coastal people", a group of hunting and gathering communities indigenous to central California (Kroeber 1925) inhabited the Santa Clara Valley. Linguistic analysis suggests that the Costanoans arrived in the San Francisco Bay region around A.D. 500 (Levy 1976). The term Costanoan as applied by anthropologists does not imply the existence of a politically unified entity, but rather refers to different groups of people who shared similar cultural traits and belonged to the same linguistic family. Descendants of the group that currently reside in the San Francisco Bay Area generally prefer the term "Ohlone."

ARC lies within the Tamyen (Tamien) and Ramaytush areas of the Ohlone geographic range. Based on Spanish mission records and archaeological data, researchers have estimated a 1770 population of 1,000 to 1,200 individuals for this area (Levy 1978; King

1977). Within the Tamyen and Ramaytush areas, the population was further subdivided into tribelets. Kroeber (1925) identifies the Posol-mi tribelet within present-day ARC.

The place name Posol-mi is probably derived from Rancho Posolmi, the grant confirmed to Native American Lopez Indigo (alternatively Ynigo), et al., in 1881. Ynigo occupied the land east of the City of Mountain View as early as 1834 (Hendry and Bowman 1940 in Basin Research Associates 1991). Lopez Indigo and other Native Americans are known to have farmed the ARC property from at least 1834 through 1864.

Historic accounts from the 1770s to 1790s and archaeological data suggest that a number of tribelets may have had temporary camps within the vicinity of ARC. However, the Ohlone way of life seems to have disappeared by 1810 due to introduced diseases, declining birth rates, and the impact of the mission system. The Ohlone people were transformed from hunters and gatherers into agricultural laborers (and in some cases, craft artisans). They lived at the missions and worked with former neighboring groups. (Levy 1978 in Basin Research Associates 1991).

Although the area around ARC continued to be settled in the early part of the 19th century, the patterns of use changed. The economy began to focus on the growth of agricultural crops and the transportation of those crops to market through a series of landings and associated warehouses along the San Francisco Bay. The Native Americans from Mission Santa Clara were apparently involved in the hide and tallow trade that coursed up and down the Guadalupe River between 1820 and 1850. Individuals from the mission carried the products down to the embarcadero where they could be loaded onto ships. Later, because of the secularization of the missions by Mexico in 1834, most of the aboriginal population gradually moved to ranchos to work as manual laborers. (Levy 1978 in Basin Research Associates 1991).

7.3.2. HISTORIC SETTING

The following historic setting was obtained from Basin Research Associates (1991.

Spanish explorers in the late 1760s and 1770s were the first Europeans to traverse the Santa Clara Valley. The first party, that of Gaspar de Portola and Father Juan Crespi, arrived in the Alviso-San Jose area in the fall of 1769. Sergeant Jose Francisco Ortega of the Portola and Crespi party was sent to explore the eastern portion of the San Francisco Bay. The second Hispanic exploration party, that of Juan Bautista de Anza and Father Pedro Font, reached the lower Guadalupe River in early 1776. The favorable reports of Anza and Font led to the establishment of both Mission Santa Clara and the Pueblo San Jose de Guadalupe in 1777.

The Mexican revolt against Spain (1822) followed by the secularization of the missions (1834) significantly changed land ownership patterns in the Santa Clara Valley. Whereas the Spanish philosophy of government was directed toward the founding of presidios, missions, and secular towns, the Mexican policy stressed individual ownership of the land. During the Mexican Period, vast tracts of land, including former mission lands, were granted to individuals.

After 1875, horticulture became widespread due to successful crop experimentation and the expansion of markets via rail. The shift from livestock to horticulture permitted smaller parcels of land and generated a labor-intensive but profitable product. In the 1880s, after the development of the refrigerator railroad car, horticulture became Santa Clara Valley's primary land use. Throughout this period, Santa Clara Valley's population increased substantially.

During the first half of the 20th century, the Cities of Mountain View, Sunnyvale, Milpitas, and San Jose were isolated central services centers surrounded by farmsteads and acres of agricultural lands. This predominance of fruit production/processing held steady until after World War II. In the second half of the century, dense urban housing, commercial centers, and the electronics industry displaced Santa Clara Valley's agrarian land use.

7.4. EXISTING SITE CONDITIONS

7.4.1. ARCHAEOLOGICAL RESOURCES

A portion of ARC is situated on the west part of Rancho Posolmi (see discussion above). Several adobe dwellings were located in the ARC area, but they were destroyed long ago. According to previous historic documents, no structures were located at ARC during most of the second half of the 18th century (Basin Research Associates 1991).

According to a review of existing data, several recorded prehistoric archaeological resources are located throughout the ARC site. Most subsurface resources are on the southeast side of the site. These resources are associated with prehistoric dwellings ranging from small temporary encampments to large villages such as that identified as Posol-mi (Kroeber 1925).

One recorded resource, CA-SC1-23, was located in a previously cultivated field on the western portion of ARC known as the Kitchen Midden site. It was recorded in the early part of the 20th century and was supposedly still extant in the mid-1950s (Soil Conservation Service 1956). Investigations conducted for NASA in the 1970s and 1980s, however, did not result in the location of this site. Therefore, Basin Research Associates (1991) conducted a detailed surface survey and mechanically assisted subsurface testing program. Fifty-eight backhoe test units were excavated in a grid-like pattern in the project area. No artifacts associated with past site occupation were detected at or below the surface. Destruction by agricultural practices (that is, dispersion) is a likely cause of the site's disappearance. The findings of Basin Research Associates (1993) were submitted to the SHPO, who concurred with the determination that the CA-SC1-23 site is no longer extant (SHPO 1994).

Although 10 other prehistoric or prehistoric/historic archaeological sites have been previously recorded within the boundaries of ARC (four are associated with Ynigo), these sites no longer exist (Basin Research Associates 1991).

In summary, no known, extant archeological resources at ARC qualify for inclusion on the NRHP. The integrity of all archaeological resources was apparently destroyed by past agricultural practices (for example, disking and tilling) or construction of the airfield.

7.4.2. HISTORIC RESOURCES

This discussion of historic resources at ARC is based on the NASA Ames Research Center Historic Resources Protection Plan for portions of Moffett Field, California (NASA 2001), the NASA Ames Research Center Section 106 Survey (NASA 1995), and on the following surveys.

Several surveys of historic resources have been undertaken at ARC to determine buildings' eligibility for listing on the NRHP. In 1984, the National Park Service did a survey of NASA centers. As a result of this survey, the Unitary Plan Wind Tunnel Complex was listed on the NRHP as a historic landmark (National Park Service 1984).

In 1991, the Navy conducted a Section 106 survey on a subset of buildings at Moffett Field and the Crows Landing Naval Auxiliary Landing Field (U.S. Navy 1994). The historic context of this survey was the 1930 to 1935 (military) and 1942 to 1946 (engineering) periods. A total of 43 buildings and structures were determined to be eligible for NRHP listing, all at Moffett Field. The area encompassed by the 43 eligible buildings/structures was named Shenandoah Plaza in honor of the first American dirigible. In 1994, the Shenandoah Plaza Historic District was listed on the NRHP.

In 1995, NASA conducted a Section 106 review for 19 buildings within the ARC campus area built before 1950 (NASA 1995). A total of three structures were found to be eligible for NRHP listing: the Administration Building (N-200), the 12- by 24-meter (40- by 80-foot) wind tunnel (N-221), and the 2- by 2-meter (6- by 6-foot) supersonic wind tunnel (N-226). These buildings are currently being nominated to the NRHP.

In 1999, Science Applications International Corporation conducted a survey for NASA of all buildings at ARC dating from the Cold War era, 1946 to 1989 (Science Applications International Corporation 1999). This survey of 124 buildings concluded that none of the Cold War-era buildings at ARC reached the level of exceptional significance required under the criteria for Cold War significance (Criteria G) to make them eligible for the NRHP.

In 2000, Beyond Buildings conducted a Section 106 survey for NASA of Buildings 148 through 156, 158, and 167, none of which were found to be eligible for listing on the NRHP (Beyond Buildings, Lori Garcia 2000).

In 2001, Architectural Resources Group conducted a Section 106 survey for NASA of Buildings N-204, N-204A, N-205, N-206, N-207A, N-208, N-209, N-222, N-223, and N-218A in the ARC campus area, all of which were approaching 50 years of age. None were found to be eligible for listing. (Architectural Resources Group 2001).

In summary, one district and four individual buildings at ARC are included or eligible for inclusion on the NRHP: the Shenandoah Plaza Historic District, the Administration Building (N-200) , the Unitary Plan Wind Tunnel Complex (N-227), the 12- by 24-meter (40- by 80-foot) Wind Tunnel (N-221), and the 2- by 2-meter (6- by 6-foot) Supersonic Wind Tunnel (N-226).

7.4.2.1. Shenandoah Plaza Historic District

On February 24, 1994, the Shenandoah Plaza Historic District was officially added to the NRHP. Shenandoah Plaza is important nationally because of its association with the expanding coastal defense capabilities of the U.S. Navy and airship technology during the 1932-1945 period.

Figure 7-1 (Figure 3.13-1 in EIS) shows the location of the Shenandoah Plaza Historic District and historic buildings within Moffett Field. The plaza consists of 97 buildings, structures, and objects, 43 of which contribute to its historic significance. The plaza's significant buildings, structures, and objects that are under NASA's jurisdiction are listed in Table 7-1. The rest are within Westcoat Housing Complex and are under the stewardship of the U.S. Department of Defense (DOD). Non-contributing buildings within Shenandoah Plaza that are under NASA's stewardship are listed in Table 7-2. The "contributing" buildings and structures are representative of the development of the original Naval Air Station Sunnyvale in the early 1930s (NAS Sunnyvale was renamed NAS Moffett Field in 1942). The buildings, landscapes, and objects included in the district are listed on the NRHP because of their association with the Navy's effort to develop lighter-than-air technology (that is, dirigibles) during the inter-war period between 1932 and 1945, and because of their distinctive site plan and Spanish Colonial Revival architecture.

Table 7-1 Contributing Buildings, Structures, and Objects within the Shenandoah Plaza Historic District (NASA Stewardship Only)

Bldg. No.	Current Identification	Historic Use*	Date Built
1	Hangar 1	Hangar 1	1933
2	Gymnasium	Balloon Hangar	1933
5	Water Storage Tower	Water Tower	1933
10	Boiler Plant Facility Shop	Heat Plant	1933
15	NASA Security, Employee Badging Office	Fire Station/Laundry	1933
16	Maintenance Shops & Offices	Locomotive Crane Shed	1933
17	Naval Air Reserves, Santa Clara HQ	Admirals Building	1933
18	Army Explosive Ordnance Department	Aerological Center	1933
19	NASA Research Support	Bachelor Enlisted Quarters	1933
20	Bachelor Officers Quarters	Bachelor Officers Quarters	1933
21	Bachelor Officers Quarters Detached Garage	Bachelor Officers Quarters Garage	1933
22	Bachelor Officers Quarters Detached Garage	Bachelor Officers Quarters Garage	1933
23	Army Reserve Center	Dispensary	1933
24	Offices	Ambulance Garage	1933
25	Theater, Army Reserves Center	Bowling Alley/Theater	1933
26	Visitor Badging Office	Gate House/Iron Fence	1933
32	North Floodlight Tower	Floodlight Tower	1933
33	South Floodlight Tower	Floodlight Tower	1933
37	Scale House	Scale House	1933
46	Hangar 2	Hangar 2	1943
47	Hangar 3	Hangar 3	1943
55	Boiler House for Hangars 2 and 3	Heat Plant for Hangars 2 and 3	1943
N/A (40)	Flagstaff	Flagpole	1933
N/A	Commons	Commons	1933
N/A	Memorial Anchor	Anchor	pre-1950
*Source: NASA Ames Research Center 2000.			

Table 7-2 Non-Contributing Buildings within the Shenandoah Plaza Historic District (NASA Stewardship Only)

Bldg. No.	Current Identification	Date Built	Reason for Ineligibility
3	Moffett Conference/Banquet Center	1933	Loss of integrity
6	Public Works/Recycling, Storage	1933	Loss of integrity
12	Commissary	1933	Loss of integrity
13	Commissary Storage	1933	Loss of integrity
14	Moffett Field Police	1933	Loss of integrity
29	Office Equipment/Repair	1932	Loss of integrity
31	Commissary/Storage	1933	Loss of integrity
34	Photo Shop	1934	Unremarkable
36	Sentry House, Main Gate	1934	Loss of integrity
44	Storage Facility	1942	Unremarkable
45	NAR Hazardous Materials Building	1944	Unremarkable
64	Storage, Shop	1940	Unremarkable
67	Post Office	1943	Unremarkable
76	Lock Smith	1944	Loss of integrity
79	Battery, Supply Storehouse	1944	Unremarkable
81	Maintenance Storage	1944	Unremarkable
85	Metalizing, Sandblasting Shop	1944	Unremarkable
93	Aircraft Shop	1946	Unremarkable
115	Storage, Decontamination	1943	Unremarkable
117	Storage	1944	Unremarkable
126	Warehouse	1949	Unremarkable

Bldg. No.	Current Identification	Date Built	Reason for Ineligibility
133	Hazardous, Flammable Storage	1950	Unremarkable
175	Line Maintenance Shelter	1956	Unremarkable
346	Aircraft Line Operations Building	1950	Unremarkable
350	Line Maintenance Shelter	1950	Unremarkable
367	Storage	1948	Unremarkable
460	Storage	1950	Unremarkable
470	Storage	1933	Unremarkable
472	Airframes Shop		Unremarkable
478	Standby Generator	1963	<50 Years Old
482	Painting & Washing Facility	1963	<50 Years Old
493	Swimming Pool, Officer Area	1963	<50 Years Old
498	Covered HazMat Storage Area	1965	<50 Years Old
499	Ground Support Equipment Shed	1966	<50 Years Old
501	Fire Station, AIB	1940	Loss of integrity
509	Exchange Shop	1968	<50 Years Old
510	NASA Maintenance Office	1967	<50 Years Old
527	Storage Shed	1968	<50 Years Old
539	Flight Line Storage	1972	<50 Years Old
540	Flight Line Storage	1972	<50 Years Old
542	Incinerator	1973	<50 Years Old
566	Plant Engineering Support Office	1979	<50 Years Old
567	Warehouse	1978	<50 Years Old
569	Air Force, Special Investigations	1978	<50 Years Old

Bldg. No.	Current Identification	Date Built	Reason for Ineligibility
570	Maintenance Storage	1978	<50 Years Old
941	Administration Office, Navy Exchange	1940	Loss of integrity
942	Navy Exchange, Crafts	1940	Loss of integrity

Site Plan and Landscape

The 1933 site plan, created by the Navy Department Bureau of Yards and Docks, is based on an axial layout with major administrative buildings set symmetrically along a generous 1.5-hectare (4.5-acre), horseshoe-shaped central greensward. The formal lawn sweeps eastward to the immense streamlined form of Hangar 1, which provides a majestic focal point for the Shenandoah Plaza Historic District and for ARC as a whole.

The landscaping is another particularly striking aspect of the original site plan. The original design's broad expanses of lawn and rows of mature liquid amber trees have been preserved, and give the Shenandoah Plaza Historic District a formal, park-like feel quite distinct from the surrounding landscape of the Baylands.

Contributing Buildings

There are 43 historic buildings within the Shenandoah Plaza Historic District, 25 of which are within ARC (the others are within the Berry Court Military Housing area). Table 7-1 lists the NASA-controlled contributing buildings within the Shenandoah Plaza Historic District, and Figure 7-1 identifies the contributing buildings within ARC

The Spanish Colonial Revival style dominates, with its neutral colors, red tile roofs, terracotta ornamentation, and almost residential proportions. Buildings in the Shenandoah Plaza Historic District are typically two stories tall, with low-pitched, slightly hipped rooflines. Exterior walls are consistently quite plain, except for a stringcourse around the entire perimeter of each building separating the first and second floors. Windows are simple rectangular shapes, vertically oriented, multi-paned, and double-hung. Flowery terracotta ornamentation defines the major front and back entrances, and often some of the most prominent windows.

Key Historic Resources

Of the historic buildings within the Shenandoah Plaza Historic District, the most striking are the Administration Building (Building 17), which sits at the head of Shenandoah Plaza, the Bachelor Officers Quarters (Building 20), and the original hangars, especially Hangar 1.

The almost 1,800-square meter (19,000 square foot) Administration Building, constructed in 1933, follows the typical architectural pattern of the original campus design: two stories high with stucco walls, red tile roofing, and terracotta ornamentation. It is the most prominently sited building within the original 1933 campus plan. Unlike the other buildings in the Shenandoah Plaza Historic District, the Administration Building's primary entrance projects out from the main structure, with a triple round-arched entrance. The detailing around the major entrances and windows includes ornamental urns, pilasters, and floral sculpture that counterpoint the austere, shallow cruciform shape of the building. There is also a small, centered bell tower with flat arches on each of its faces, capped by a small red dome.

The Bachelor Officers Quarters (Building 20), constructed in 1933, is also a large two-story structure in the typical Spanish Colonial style of the Shenandoah Plaza Historic District buildings. It sits on the south side of the plaza where the central green widens outwards, facing the equally prominent but less architecturally impressive Bachelor Enlisted Quarters. The Bachelor Officers Quarters has more ornamentation than other buildings in the Shenandoah Plaza Historic District, and a very elegant entryway of three large round arches. A rear wing projects south from the building and abuts the original 1933 officer automobile storage structures, Buildings 22, and 21.

The most significant building in the Shenandoah Plaza Historic District, however, is Hangar 1, which was designed in the Streamline Moderne style to emulate the sleek, ultra-modern form of the airship it was built to house rather than the Spanish Colonial Revival architecture of the rest of the original core of Moffett Field. The giant parabola of Hangar 1 towers 65 meters (211 feet) above the plaza. Constructed in 1932 through 1933, this one-story steel truss building is one of the largest non-internally supported buildings in the United States, enclosing 3 hectares (8 acres) of land. The smooth curve of its plate metal cladding is detailed on each side with bands of horizontally oriented windows set flush in the skin. Gigantic curving doors on tracks create the north and south ends of the buildings. Hangar 1 is historically significant because of its unique use, its beautifully executed Streamline Moderne design, its ingenious structural construction, and its size; it is still the dominant landmark in the southern San Francisco Bay Area. In addition to anchoring the Shenandoah Plaza Historic District, Hangar 1 has been designated a Naval Historical Landmark and a California Historic Civil Engineering Landmark by Section 57 of the American Society of Civil Engineering.

7.4.2.2. Ames Research Center Campus Historic Buildings

This section describes the historic buildings within the ARC campus.

The Unitary Plan Wind Tunnel Complex

The Unitary Plan Wind Tunnel Complex (Building N-227) is the only building at ARC that is currently included on the NRHP. It was listed as a National Historic Landmark on the NRHP in 1985 because of its significant association with the development of the American space program. It has also been designated an International Historic Mechanical Engineering Landmark. The Unitary Plan Wind Tunnel Complex consists of three separate wind tunnels, each of which loops back to connect to the same central 193,880-megawatt (260,000-horsepower) engine. Covering 7,100 square meters (77,000 square feet), the three huge loops of metal conduit create one of the most striking architectural landmarks at ARC.

Other Elements

In 1995, ARC conducted a historical survey of 19 additional buildings that had been built in 1950 or earlier. Three of these buildings (N-200, N-221, and N-226) were determined to be eligible for inclusion on the NRHP. These buildings are associated with the advancement of aeronautics, science, and exploration during World War II and the post-war period (1940-1950). The findings of this survey were submitted in November 1995 to the California SHPO for review. The SHPO did not formally respond to the submittal, although ARC requested a formal response in December 1997. Historic buildings at ARC are listed in Table 7-3.

Table 7-3 Historic Buildings at the Ames Campus

Bldg. No.	Current Identification	Date Built
N-200	Administration Building- (nominated)	1943
N-221	12- by 24-meter (40- by 80-foot) Wind Tunnel-nominated	1944
N-226	2- by 2-meter (6- by 6-foot) Supersonic Wind Tunnel-nominated	1946
N-227	Unitary Plan Wind Tunnel	1954

The Administration Building (N-200) was constructed in 1943 and dates back to the earliest years of the ARC. Its importance relative to the other structures at the ARC is signified by the greater degree of ornamental detail near the windows and entry, as well as its formal, symmetrical facade. As the Administration Building, it housed ARC's management during its gradual transformation from an aeronautical laboratory emphasizing high-speed wind tunnel research to the diverse and sophisticated research campus of today.

The 12- by 24-meter (40- by 80-foot) Wind Tunnel (N-221) is the single most prominent landmark within the ARC campus area. This structure is the largest wind tunnel in the world. For almost 40 years, it was a closed-system tunnel. An expansion from 1979 to 1982 created an additional 24- by 37-meter (80- by 120-foot) test section with an open-intake air system. The wind tunnel was designed to test full-scale aircraft. It was used during the last year of World War II, and it served as the test site of the first U.S. aircraft with a jet engine, the Ryan XFR-1.

The 2- by 2-meter (6- by 6-foot) Supersonic Wind Tunnel (N-226) is the site of testing that led to significant advances in the fields of aerodynamics and space exploration by helping to solve the mysteries of flight beyond Mach 1. The supersonic wind tunnel included a feature that allowed a range of speeds from Mach 1.3 to 1.8, and 130-centimeter (50-inch) glass windows for researchers to observe the flow of supersonic air around the models in the tunnel.

7.4.3. COLD WAR RESOURCES

In March 1999, an Inventory and Evaluation of Cold War Era Historical Resources of Moffett Federal Airfield and the NASA Crows Landing Flight Facility (formerly Naval Auxiliary Landing Field) were conducted. The survey concluded that, of the 148 buildings and structures evaluated, none were considered eligible for listing on the NRHP. Twenty of these buildings were used specifically to support the P-3 Orion anti-submarine warfare mission at Moffett Federal Airfield. Although the mission was considered of exceptional national significance within the Cold War context, the buildings themselves do not exhibit special architectural or engineering features that would give them exceptional significance as representatives of the Cold War P-3 mission. The remaining 128 buildings and structures are considered support buildings found at any installation and therefore are not considered significant (Inventory and Evaluation of Cold War Era Historical Resources Moffett Field/NASA Crows Landing Flight Facility Alexandra Cole 1999).

7.5. ENVIRONMENTAL MEASURES

NASA is committed to the preservation and rehabilitation of existing cultural resources on the ARC site when feasible and practicable. Therefore, NASA has identified the following guidelines to be implemented during all construction, demolition, and/or

7.5.1. . HISTORIC RESOURCE PROTECTION PLAN

NASA's HRPP sets out nine preservation management goals and policies for the Shenandoah Plaza Historic District. The HRPP also categorizes all properties within the district following a system of National Register Treatment Categories based on those developed by various branches of the DOD. NRHP eligibility has been determined for all Shenandoah Plaza buildings. Yet within this group, there is flexibility for determining treatment categories. Each of the four treatment categories proposes a particular level of preservation treatment suitable for the significance of the resources within it. The HRPP states that all undertakings that may affect the Shenandoah Plaza Historic District shall implement treatments as outlined in the plan.

Any future projects that involve the rehabilitation of contributing buildings within the Shenandoah Plaza Historic District would also follow the HRPP. Appropriate landscaping would be used to avoid impacts to historic buildings. The HRPP includes the guidelines for the rehabilitation of historic structures located at ARC. New additions would be located on secondary facades. Restoring facades that have been previously altered would be considered as an alternative.

7.5.2. DESIGN GUIDELINES

To protect and preserve the integrity of historic structures, design guidelines for historic structures would be modified to include the following:

- Replacement glass would be with like kind
- No change of exterior material would occur
- Installation of utilities would not affect historic character-defining features
- New materials would not affect the historic integrity of original materials
- Ground-disturbing activities would match materials in-kind

To protect the physical integrity of historic structures further during rehabilitation activities, the State Historical Building Code would be used when planning for structural stability or the installation of protective or code-required mechanical systems or access.

7.5.3. VISUAL INTEGRITY

In addition to rehabilitation of individual structures, infill development associated with future projects within the Shenandoah Plaza Historic District could threaten the district's visual integrity. Any new building or addition to an existing building constructed within the portion of the Shenandoah Plaza Historic District that lies within ARC would follow the HRRP, which includes the Design Guidelines for New Construction in the Shenandoah Plaza Historic District. These guidelines set parameters for compatible designs including orientation, height, setback, materials, and style. The guidelines also indicate which areas must not be used as building sites. Any project undertaken within the vicinity of designated or potentially designated resources, structures, or districts would be subject to review by the SHPO through the Section 106 process. Any agreed-upon mitigation, such as plan modification and design harmony, would be undertaken.

7.5.4. CONSTRUCTION MEASURES TO PROTECT ARCHAEOLOGICAL RESOURCES

As described in Section 7.4.1, Archaeological Resources, although 10 prehistoric and historic archaeological sites were discovered and formally recorded on or near the current site of ARC early in this century, it is no longer possible to find evidence of any of the sites that lay within the ARC itself. They appear to have been seriously disturbed or destroyed by agriculture, fill, and development over the course of the century. While it appears that NASA's current operations do not adversely affect cultural resources at ARC, it is possible that these lost sites could be rediscovered during construction or demolition activities associated with future development at ARC, or that previously unknown remains could be uncovered.

Construction activities could disturb lost or undiscovered subsurface archaeological resources on the site. In the event that human remains and/or cultural materials are found, all construction would cease within a 15-meter (50-foot) radius in order to proceed with the testing and mitigation measures required pursuant to Section 7050.5 of the Health and Safety Code and Section 5097.94 of the Public Resources Code of the State of California. The SHPO and the NASA Federal Preservation Officer would be contacted as soon as possible. Construction in the affected area would not resume until the regulations of the Advisory Council on Historic Preservation (36 CFR Part 800) have been satisfied. In the event of the discovery of human remains, the project manager would notify the Santa Clara County Coroner. The coroner would make the determination as to whether the remains are Native American. If the coroner determines that the remains are not subject to his or her authority, s/he would notify the Native American Heritage Commission, who would attempt to identify the descendants of the deceased Native American. If no satisfactory agreement can be reached as to the disposition of the remains pursuant to state law, then the remains would be reinterred with items associated with the Native American burial on the property in a location not subject to further disturbance.

Chapter 8. Air Quality

8.1. OVERVIEW

This chapter describes the regional setting of the NASA Ames Research Center (ARC), including climatic and meteorological conditions, and summarizes measured air pollutant concentrations representative of existing project conditions. It also summarizes the federal, state, and local air quality regulations applicable to facilities, operations, and other activities at ARC. Information in Section 8.3, Regional Setting, was obtained from the NASA Ames Development Plan Final Programmatic Environmental Impact Statement (Design, Community & Environment 2002).

The ambient air quality in a given area depends on the quantities of pollutants emitted within the area, transport of pollutants to and from surrounding areas, local and regional meteorological conditions, and the surrounding topography of the air basin. Air quality is described by the concentration of various pollutants in the atmosphere. Units of concentration are generally expressed in parts per million (ppm) or micrograms per cubic meter ($\mu g/m^3$). The significance of a pollutant concentration is determined by comparing the concentration to an appropriate ambient air quality standard, which restricts allowable pollutant concentrations to protect public health and welfare while including a reasonable margin of safety to protect the more sensitive individuals in the population.

8.2. REGULATORY REQUIREMENTS

This section describes federal, state, and regional air quality standards for ARC and the vicinity.

8.2.1. FEDERAL AND STATE AIR QUALITY STANDARDS

Both the federal government and the State of California have established ambient air quality standards for "criteria" pollutants (Table 8-1). These criteria pollutants now include carbon monoxide (CO), ozone (O_3), nitrogen dioxide (NO_2), particulate matter with a diameter less than 10 microns (PM_{10}) and those with a diameter of 2.5 microns or less ($PM_{2.5}$), sulfur dioxide (SO_2), and lead (Pb). The air pollutants for which standards have been established are considered the most prevalent air pollutants known to be hazardous to human health.

Table 8-1 Federal and State Air Quality Standards

Pollutant	Symbol	Average Time	Standard (parts per million) California	Standard (parts per million) National	Standard (micrograms per cubic meter) California	Standard (micrograms per cubic meter) National	Violation Criteria California	Violation Criteria National
Ozone	O_3	1 hour	0.09	0.12	180	235	If exceeded	If exceeded on more than 1 day per year
		8 hours	NA	0.08	NA	157	NA	If fourth highest 8-hour concentration in a year, averaged over 3 years, is exceeded at each monitor within an area
Carbon monoxide	CO	8 hours	9	9	10,000	10,000	If exceeded	If exceeded on more than 1 day per year
		1 hour	20	35	23,000	40,000	If exceeded	If exceeded on more than 1 day per year
(Lake Tahoe only)		8 hours	6	NA	7,000	NA	If equaled or exceeded	NA
Nitrogen dioxide	NO_2	Annual average	NA	0.053	NA	100	NA	If exceeded on more than 1 day per year
		1 hour	0.25	NA	470	NA	If exceeded	NA
Sulfur dioxide	SO_2	Annual average	NA	0.03	NA	80	NA	If exceeded
		24 hours	0.04	0.14	105	365	If exceeded	If exceeded on more than 1 day per year
		1 hour	0.25	NA	655	NA	If exceeded	NA
Hydrogen sulfide	H_2S	1 hour	0.03	NA	42	NA	If equaled or exceeded	NA
Vinyl chloride	C_2H_3Cl	24 hours	0.01	NA	26	NA	If equaled or exceeded	NA
Inhalable particulate matter	PM10	Annual geometric mean	NA	NA	20	NA	If exceeded	NA

Pollutant	Symbol	Average Time	Standard (parts per million) California	Standard (parts per million) National	Standard (micrograms per cubic meter) California	Standard (micrograms per cubic meter) National	Violation Criteria California	Violation Criteria National
		Annual arithmetic mean	NA	NA	NA	50	NA	If exceeded at each monitor within area
		24 hours	NA	NA	50	150	If exceeded	If exceeded on more than 1 day per year
	PM2.5	Annual geometric mean	NA	NA	NA	NA	If exceeded	NA
		Annual arithmetic mean	NA	NA	12	15	NA	If 3-year average from single or multiple community-oriented monitors is exceeded
		24 hours	NA	NA	NA	65	NA	If 3-year average of 98th percentile at each population-oriented monitor within an area is exceeded
Sulfate particles	SO_4	24 hours	NA	NA	25	NA	If equaled or exceeded	NA
Lead particles	Pb	Calendar quarter	NA	NA	NA	1.5	NA	If exceeded no more than 1 day per year
		30-day average	NA	NA	1.5	NA	If equaled or exceeded	NA

Notes: All standards are based on measurements at 25°C and 1 atmosphere pressure.
National standards shown are the primary (health effects) standards.
NA = not applicable.

Source: California Air Resources Board, "Area Designations for State and National Ambient Air Quality Standards."

8.2.1.1. Ozone

Ground-level O_3 is the principal component of smog. It is not directly emitted into the atmosphere, but is formed by the photochemical reaction in the presence of sunlight of reactive organic gases (ROG) and nitrogen oxides (NO_x) (known as ozone precursors). O_3 levels are highest during late spring through early summer, when precursor emissions are high and meteorological conditions are favorable for the complex photochemical reactions to occur. Approximately half of the ROG and NO_x emissions in the Bay Area are from motor vehicles. Adverse health effects of ground-level O_3 include respiratory impairment and eye irritation. High O_3 concentrations are also a potential problem to sensitive crops, such as wine grapes.

8.2.1.2. Carbon Monoxide

CO is a non-reactive pollutant that is highly toxic, invisible, and odorless. It is formed by the incomplete combustion of fuels. The largest source of CO emissions is motor vehicles; wood stoves and fireplaces also contribute. Unlike O_3, CO is directly emitted into the atmosphere. The highest CO concentrations occur during the nighttime and early mornings in late fall and winter. CO levels are strongly influenced by meteorological factors, such as wind speed and atmospheric stability. Adverse health effects of CO include the impairment of oxygen (O_2) transport in the bloodstream, increase of carboxyhemoglobin, aggravation of cardiovascular disease, impairment of central nervous system function, fatigue, headache, confusion, and dizziness. Exposure to CO can be fatal with very high concentrations in enclosed places.

8.2.1.3. Nitrogen Dioxide

NO_2 is a reddish-brown gas that is a byproduct of combustion processes. Automobiles and industrial operations are the primary sources of NO_2. NO_2 contributes to O_3 formation. Adverse health effects associated with exposure to high levels of NO_2 include the risk of acute and chronic respiratory illness.

8.2.1.4. Sulfur Dioxide

SO_2 is a colorless gas with a strong odor and the potential to damage materials. It is produced by the combustion of sulfur-containing fuels such as oil and coal. Refineries and chemical plants are the primary sources of SO_2 emissions in the Bay Area. Adverse health effects associated with exposure to high levels of SO_2 include aggravation of chronic obstructive lung disease and increased risk of acute and chronic respiratory illness.

8.2.1.5. Inhalable Particulate Matter

Inhalable particulate matter (PM_{10} and $PM_{2.5}$) refers to a wide variety of solid or liquid particles in the atmosphere. These include smoke, dust, aerosols, and metallic oxides. Some of these particulates are considered toxic. Although particulates are found naturally in the air, most particulate matter found in the Bay Area is emitted either directly or indirectly by motor vehicles, industry, construction, agricultural activities, and wind erosion of disturbed areas. Most $PM_{2.5}$ is comprised of combustion products of diesel and other materials. Small particulate matter may be inhaled and may lodge in and/or irritate the lungs. Exposure to small particulate matter can increase the risk of chronic respiratory illness with long-term exposure, and altered lung function in children. Recent research indicates that exposure to $PM_{2.5}$ increases the risk of arthrosclerosis.

8.2.1.6. Lead

Pb occurs in the atmosphere as particulate matter. It was primarily emitted by gasoline-powered motor vehicles. Because the use of Pb in fuel has been virtually eliminated, Pb levels in the Bay Area have dropped dramatically and are well below the ambient standards.

8.2.1.7. Toxic Contaminants

Besides the six criteria air pollutants described above, there is another group of substances found in ambient air referred to as toxic air contaminants. These contaminants (hydrogen sulfide (H_2S), vinyl chloride (C_2H_3Cl), and sulfates (SO_4)) tend to be localized and are found in relatively low concentrations in ambient air. However, they can result in adverse chronic health effects if exposure to low concentrations occurs for long periods. They are regulated at the local, state, and federal levels

8.2.2. FEDERAL AIR QUALITY REGULATIONS

This section describes the Bay Area's compliance with the National Ambient Air Quality Standards (NAAQS), and the conformity analysis process.

8.2.2.1. Compliance within National Ambient Air Quality Standards

If an area does not meet one of the NAAQS over a 3-year period, the U.S. Environmental Protection Agency (EPA) designates it as a "nonattainment" area for that particular pollutant. EPA requires states with nonattainment areas to prepare and submit air quality plans showing how the standards will be met in the future or, if they cannot be met, how they can show progress toward meeting the standards. These air quality plans are referred to as state implementation plans (SIPs). Under severe cases, EPA may impose a federal plan.

Prior to 1998, the Bay Area was a "moderate nonattainment" area for CO due to localized exceedances of the national CO standards in downtown San Jose and Vallejo. The CO standards have not been exceeded since 1991. In 1998, EPA approved the San Francisco Bay Area Redesignation Request and Maintenance Plan for the National Carbon Monoxide Standard and reclassified the area as a CO "maintenance" area.

Prior to 1995, the San Francisco Bay Area Air Basin was classified by EPA as a “moderate nonattainment” area for O_3 since some air pollutant monitors in the area routinely measure concentrations exceeding the national 1-hour O_3 standard. In 1993, after 3 years of monitoring compliance with the 1-hour O_3 standard, the Bay Area Air Quality Management District (BAAQMD) submitted the 1993 Ozone Maintenance Plan to EPA to request the redesignation of the region to an O_3 maintenance area. The plan included measures to maintain the attainment of the O_3 NAAQS.

In 1995, EPA granted the request and classified the Bay Area as a "maintenance" area after the region had not violated the O_3 standard for 5 years (1990-1994). However, violations of the national 1-hour O_3 standard occurred during the summers of 1995 and 1996. As a result, in 1997 EPA revoked the region's clean air status and designated the area as an "unclassified nonattainment" area for O_3.

In response to the redesignation of the area to an O_3 nonattainment area, the Bay Area co-lead agencies (BAAQMD, the Metropolitan Transportation Commission, and the Association of Bay Area Governments (ABAG)) prepared and submitted the San Francisco Bay Area Ozone Attainment Plan, or Ozone SIP, to the California Air Resources Board (CARB). This plan, which was a revision to the 1993 Ozone Maintenance Plan, was submitted to EPA in 1999. The plan includes a compilation of existing and proposed plans and regulations that govern how the region complies with the federal Clean Air Act requirements. This plan was designed to show how the region would attain the federal O_3 standard by the end of the 2000 O_3 season (summer) and thereafter.

EPA defines attainment of the national 1-hour O_3 standard as when the Bay Area does not record an exceedance of the O_3 standard more than three times in one year for three consecutive years. The Bay Area continued to violate the O_3 NAAQS in 1998; therefore, attainment of the standard was not possible before 2000. In March 2001, EPA formally announced that the region had not attained the 1-hour O_3 standard and it would only partially approve the plan. As a result, a new Ozone Attainment Plan was developed and submitted to CARB and EPA. This plan is required to demonstrate attainment of the 1-hour O_3 standard by 2006. Currently BAAQMD, in cooperation with the Metropolitan Transportation Commission and ABAG, is preparing the Bay Area 2004 Ozone Strategy Plan, which is replacing the 2001 Ozone Attainment Plan. The 2004 Ozone Strategy Plan will address national and state air quality planning requirements. It will include a redesignation request and maintenance plan for the national 1-hour O_3

standard and a triennial revision to the Bay Area strategy to attain the California 1-hour O_3 standard.

The Bay Area 2001 Ozone Attainment Plan for the national 1-hour O_3 standard included two commitments for further planning: (1) a commitment to conduct a mid-course review of progress toward attaining the national 1-hour O_3 standard by December 2003, and (2) a commitment to provide a revised O_3 attainment strategy to EPA by April 2004 (BAAQMD 2004).

In April 2004, EPA made a final finding that the Bay Area had attained the national 1-hour O_3 standard. Because of this finding, the previous planning commitments in the 2001 Ozone Attainment Plan are no longer required. The finding of attainment does not mean the Bay Area has been reclassified as an attainment area for the 1-hour standard; the region must submit a re designation request to EPA in order to be reclassified as an attainment area. Therefore, the portion of the 2004 Ozone Strategy Plan addressing national O_3 planning requirements will include: (1) a redesignation request and (2) a maintenance plan to show the region will continue to meet the 1-hour O_3 standard (BAAQMD 2004). In addition, the California Clean Air Act requires BAAQMD to update the clean air plan for attaining the state 1-hour O_3 standard every 3 years. The BAAQMD Board of Directors adopted the most recent update in December 2000. The portion of the 2004 Ozone Strategy Plan addressing state O_3 planning requirements will include the triennial update to the region's strategy to attain the state 1-hour O_3 standard (BAAQMD 2004).

In preparing for the 2004 Ozone Strategy Plan, BAAQMD will assess progress toward state and federal O_3 standards, review air pollution control strategies, and determine what additional control strategies will be needed.

8.2.2.2. Conformity Analysis

Section 176(c) of the 1990 Clean Air Act Amendments outlines the "conformity" provisions for federal projects. Federal actions are required to conform to the requirements of a SIP, and must not jeopardize efforts for a region to achieve NAAQS. Section 176(c) assigns primary oversight responsibility for conformity assurance to the federal agency undertaking the project, not the EPA, state, or local agency. For there to be conformity, federally supported or funded activities must not: (1) cause or contribute to any new air quality standard violation, (2) increase the frequency or severity of any existing standard violation, or (3) delay the timely attainment of any standard, interim emission reduction, or other SIP milestone aimed at bringing the region into attainment.

In 1993, EPA issued conformity regulations (40 CFR Parts 51 and 93) that addressed transportation projects (Transportation Conformity) and conformity of all other non-transportation federal actions (General Conformity). The primary requirements of the

Transportation Conformity rule are that implementation of transportation plans or programs cannot produce more emissions of pollutants than budgeted in the latest SIP.

The General Conformity regulations apply to a wide range of federal actions or approvals that would cause emissions of criteria air pollutants above specified levels to occur in locations designated as nonattainment or maintenance areas. Since the Bay Area is in nonattainment (nonclassified) for O_3 and is a CO maintenance area, federal projects are subject to the General Conformity regulations if they generate emissions of O_3 precursor pollutants (ROG and NO_x) or CO in excess of approximately 91 tonnes (100 tons) per year, or if the emissions are more than 10% of the nonattainment or maintenance area's emission inventory for the pollutant of concern.

Projects that are subject to the General Conformity regulations are required to mitigate or fully offset the emissions caused by the action, including both direct and indirect (for example, traffic) emissions that the federal agency has some control over. BAAQMD adopted and incorporated the Transportation and General Conformity regulations into the SIP in 1994.

8.2.3. California Air Quality Regulations

The California Clean Air Act of 1988, amended in 1992, outlines a program for areas in the state to attain the California Ambient Air Quality Standards (CAAQS) by the earliest practical date. The California Clean Air Act set more stringent air quality standards for all of the pollutants covered under national standards. It also regulates levels of vinyl chloride, hydrogen sulfide, sulfates, and visibility-reducing particulates. If an area does not meet CAAQS, CARB designates the area as a nonattainment area. Based on the California standards, the Bay Area is a serious nonattainment area for O_3 (since the area cannot forecast attainment of the state O_3 standard in the foreseeable future). CARB requires regions that do not meet CAAQS for O_3 to submit clean air plans that describe plans to attain the standard. The Bay Area is also a state nonattainment area for PM_{10}. The Bay Area has met CAAQS for all other air pollutants.

8.2.4. Regional Air Quality Regulations and Planning

The local air quality regulatory agency responsible for the San Francisco Bay Area Air Basin is BAAQMD. BAAQMD regulates stationary sources (with respect to federal, state, and local regulations), monitors regional air pollutant levels (including measurement of toxic air contaminants), develops air quality control strategies, and conducts public awareness programs. BAAQMD has also developed California Environmental Quality Act (CEQA) guidelines that establish significance thresholds and provide guidance for evaluating potential air quality impacts of projects and plans.

BAAQMD has prepared the Bay Area Clean Air Plan (CAP) to address the California Clean Air Act. This plan includes a comprehensive strategy to reduce emissions from stationary, area, and mobile sources, and attain the stricter state air quality standard mandated by the California Clean Air Act. CAP is designed to achieve a region-wide reduction of O_3 precursor pollutants through the expeditious implementation of all feasible measures. Air quality plans are developed on a triennial basis, with the latest plan developed in 2000 (2000 CAP). The primary objective of the 2000 CAP is to reduce O_3 precursor pollutants through the implementation of all feasible control measures.

8.3. REGIONAL SETTING

ARC is a federal facility located on approximately 800 hectares (2,000 acres) of land between U.S. Highway 101 and the southwestern edge of the San Francisco Bay in the northern portion of Santa Clara County, California (Figures 1-1 and 1-2). The City of Mountain View borders it to the south and west, and the City of Sunnyvale to the south and east. ARC is about 56 kilometers (35 miles) south of San Francisco and 16 kilometers (10 miles) north of San Jose, in the heart of Silicon Valley. For planning purposes, ARC is divided into four subareas: the NASA Research Park, Eastside/Airfield, Bayview, and the Ames campus (Figure 1-3).

8.3.1. REGIONAL TOPOGRAPHY AND CLIMATE

ARC is located in the San Francisco Bay Area Air Basin, which includes the City of San Francisco, portions of Sonoma and Solano counties, and all of San Mateo, Santa Clara, Alameda, Contra Costa, Marin, and Napa counties.

The climate at ARC is characterized by warm, dry summers and cool, moist winters. The proximity of the San Francisco Bay and the Pacific Ocean has a moderating influence on the climate. The major synoptic feature controlling the area's climate is a large high-pressure system located in the eastern Pacific Ocean known as the Pacific High. The strength and position of the Pacific High varies seasonally. It is at its strongest when it is located off the West Coast of the United States during the summer. Large-scale atmospheric subsidence associated with the Pacific High produces an elevated temperature inversion along the West Coast. The base of this inversion is usually located from 300 to 1,000 meters (1,000 to 3,000 feet) above mean sea level, depending on the intensity of subsidence and the prevailing weather condition. Vertical mixing is often limited to the base of the inversion, trapping air pollutants in the lower atmosphere. Marine air trapped below the base of the inversion is often condensed into fog or stratus clouds by the cool Pacific Ocean. This condition is typical of the warmer months of the year, from roughly May through October. Stratus clouds usually form offshore and move into the Bay Area during the evening hours. As the land warms the following morning, the clouds often dissipate, except in areas immediately adjacent to the coast. The stratus then redevelops and moves inland late in the day. Otherwise, clear skies and dry conditions prevail during summer.

As winter approaches, the Pacific High becomes weaker and shifts south, allowing pressure systems associated with the polar jet stream to affect the region. Low-pressure systems produce periods of cloudiness, strong shifting winds, and precipitation. The number of days with precipitation can vary greatly from year to year, resulting in a wide range of annual precipitation totals. Precipitation is generally lowest along the coastline and bay, with the highest amounts occurring along south- and west-facing slopes. Annual precipitation totals for ARC ranged from about 150 to 790 millimeters (6 to 31 inches) during the 1945-1993 period of record, with an annual average of 343 millimeters (13.5 inches) (Design, Community & Environment 2002). About 90% of rainfall in the region occurs between November and April. High-pressure systems in winter can produce cool stagnant conditions. Radiation fog and haze are common during extended winter periods when high-pressure systems influence the weather.

The annual average high temperatures at ARC are 68° Fahrenheit (F)/20° Centigrade (C). Annual average low temperatures are 50°F/10°C. In July, the average high and low temperatures are 75°F and 57°F (25°C and 13°C), respectively, while in January the average high and low temperatures are 57°F and 42°F (13°C and 6°C). Extreme high and low temperatures recorded during the 48-year period of record were 105°F and 21°F (40°C and 6°C), respectively (National Oceanic and Atmospheric Administration 1995, in Design, Community & Environment 2002). Temperatures along the Bay Area are generally less extreme compared to inland locations due to the moderating effect of the Pacific Ocean. The proximity of the Eastern Pacific High and relatively lower pressure inland produces a prevailing west to northwest sea breeze along the central and northern California coast for most of the year. As this wind is channeled through the Golden Gate Bridge and other gaps, it branches off to the northeast and southeast, following the general orientation of the San Francisco Bay. As a result, the wind prevails from the north to northwest in the South Bay region and ARC during daytime hours. Nocturnal winds and land breezes during the colder months of the year prevail from the south due to drainage out of the Santa Clara Valley.

During the fall and winter months, the Pacific High can combine with high pressure over the interior regions of the western United States (known as the Great Basin High) to produce extended periods of light winds and low-level temperature inversions. This condition frequently produces poor atmospheric mixing that results in degraded regional air quality. O_3 standards traditionally are exceeded when this condition occurs during the warmer months of the year.

8.4. EXISTING SITE CONDITIONS

Air quality is affected by the rate of pollutant emissions and by meteorological conditions, such as wind speed, atmospheric stability, and mixing height, all of which affect the atmosphere's ability to mix and disperse pollutants. Long-term variations in air quality typically result from changes in air pollutant emissions, while short-term variations result from changes in atmospheric conditions.

8.4.1. SAN FRANCISCO BAY REGION

The air pollutants of greatest concern in the South Bay Area are ground-level O_3 and PM_{10} because the San Francisco Bay region as a whole does not comply with air quality standards for either pollutant. As described above, the San Francisco Bay Area annually exceeds the CAAQS for 1-hour O_3 and 24-hour average PM levels. Throughout the Bay Area, the national 1-hour O_3 standard was exceeded at one or more stations from 0 to 8 days annually over the last 5 years, and the new 8-hour O_3 standard was exceeded from 0 to 16 days annually. The number of days on an annual basis that exceeded the more stringent 1-hour state O_3 standard at one or more stations in the Bay Area ranged from 8 to 34 days per year during the past 5 years. NAAQS for PM_{10} is not exceeded anywhere in the Bay Area, but the more stringent state standard is routinely exceeded in the Bay Area, as well as most other parts of the state. No other air quality standards are exceeded in the Bay Area. As a result, the San Francisco Bay Area is considered nonattainment for ground-level O_3 at both the state and federal levels, and nonattainment for PM_{10} at the state level only. The Bay Area currently complies with state and federal standards for all other air pollutants (CO, NO_2, SO_2, and Pb).

BAAQMD monitors air pollutant levels continuously throughout the nine-county San Francisco Bay Area Air Basin. The Mountain View monitoring station, which is closest to ARC, only measures ground-level O_3 concentrations. The nearest multi-pollutant monitoring stations are in Redwood City, several miles to the north, and San Jose, several miles to the south. A summary of air quality monitoring data is shown in Table 8-2. The values in the table are the highest air pollutant levels measured at these stations over the past 5 years (1996-2000). The new 8-hour standard concentrations exceeding NAAQS or CAAQS are given in Table 8-3. State O_3 and PM_{10} standards were exceeded on several days each year.

BAAQMD operates a 17-station air toxics monitoring network throughout the Bay Area. The closest station to ARC is the Mountain View monitoring station. Two other nearby monitoring stations are located in Redwood City and San Jose. Compounds measured by BAAQMD include benzene, 1,3-butadiene, carbon tetrachloride, chloroform, ethylene dibromide, ethylene dichloride, methyl tert-butyl ether, methylene chloride, perchloroethylene, toluene, 1,1,1-trichloroethane, trichloroethylene, and vinyl chloride. Since the ambient concentrations of these toxic air contaminants are very small, they are measured and reported as parts per billion on a volume basis. Table 8-4 contains a summary of the measured toxic air contaminant concentrations for each of the compounds at the Mountain View monitoring station in 1999, and the Redwood City and San Jose monitoring stations in 2000. Maximum, minimum, and mean concentrations are presented for each compound. Also included in Table 8-4 are the overall Bay Area monitoring results, which include the maximum of all measured concentrations from all stations, the minimum concentration measured, and the mean concentrations from all Bay Area monitoring stations.

Table 8-2 Air Pollutant Concentrations Near Ames Research Center Station

Pollutant	Standard	Station Location	1996	1997	1998	1999	2000	2001
PM_{10} (µg/m³)	24 hour	San Jose	76	78	92	114	76	77
		Redwood City	48	70	49	84	53	65
PM_{10} (µg/m³)	Annual	San Jose	25	26	25	25	27	28
		Redwood City	21	24	25	29	21	22
CO (ppm)	8 hour	San Jose	7.0	6.1	6.3	6.3	6.3	5.1
		Redwood City	3.6	4.2	4.1	3.8	4.4	3.9
O_3 (ppm)	1 hour	Mountain View	0.11	0.11	0.10	0.11	–	–
		San Jose	0.11	0.09	0.15	0.11	0.07	0.11
		Redwood City	0.10	0.09	0.07	0.08	0.08	0.11
O_3 (ppm)	8 hour	Mountain View	0.08	0.08	0.06	0.09	–	–
		San Jose	0.08	0.07	0.09	0.08	0.06	0.07
		Redwood City	0.07	0.07	0.05	0.06	0.06	0.06
NO_2 (ppm)	1 hour	San Jose	0.11	0.12	0.08	0.13	0.11	0.11
		Redwood City	0.09	0.08	0.06	0.10	0.07	0.07
NO_2 (ppm)	Annual	San Jose	0.025	0.025	0.025	0.026	0.025	0.023
		Redwood City	0.020	0.018	0.018	0.019	0.018	0.016

Notes: µg/m³ = micrograms per cubic meter
ppm = parts per million
Source: BAAQMD in Design, Community & Environment 2002.

Table 8-3 Summary of Local Air Quality Exceedances

Pollutant	Standard	Station Location	1996	1997	1998	1999	2000	2001
O_3	NAAQS	Mountain View	0	0	0	0	–	–
	1 hour	San Jose	0	0	0	0	0	0
	(0.12 ppm)	Redwood City	0	0	0	0	0	0
		Bay Area	–	–	16	9	3	1
O_3	NAAQS	Mountain View	0	0	0	1	–	–
	8 hour	San Jose	0	0	1	0	0	0
	(0.08 ppm)	Redwood City	0	0	0	0	0	0
		Bay Area	8	0	8	9	4	7
O_3	CAAQS	Mountain View	3	1	2	7	–	–
	1 hour	San Jose	5	0	4	3	0	2
	(0.09 ppm)	Redwood City	1	0	0	0	0	1
		Bay Area	34	8	29	20	12	15
PM_{10}	NAAQS	San Jose	0	0	0	0	0	0
	24 hour	Redwood City	0	0	0	0	0	0
	(150 μg/m^3)	Bay Area	0	0	0	0	0	0
PM_{10}	CAAQS	San Jose	2	3	3	5	7	4
	24 hour	Redwood City	0	2	0	3	1	4
	(50 μg/m^3)	Bay Area	3	4	5	12	7	–
All other (CO, NO_2, Pb, SO_2)	All other	San Jose	0	0	0	0	0	0
		Redwood City	0	0	0	0	0	0
		Bay Area	0	0	0	0	0	0
Source: BAAQMD in Design, Community & Environment 2002.								

Table 8-4 Summary of Recently Measured Toxic Air Contaminant Concentrations Near NASA Ames Research Center (In PPB)

	Mountain View (1999)			Redwood City (2000)			San Jose (2000)			Bay Area (2000)		
Compound	**Max**	**Min**	**Mean**	**Max**	**Min**	**Mean**	**Max**	**Min**	**Mean**	**Max**	**Min**	**Mean**
Benzene	1.60	0.10	0.55	2.20	0.10	0.69	3.10	0.10	0.75	3.10	<0.10	0.46
1,3-Butadiene	0.80*	<0.30*	0.32*	1.00*	<0.30*	0.46*	1.00	0.02	0.19	NA	NA	0.17
Carbon tetrachloride	0.12	0.09	0.10	0.12	0.08	0.10	0.12	0.09	0.10	0.16	<0.02	0.01
Chloroform	0.10	<0.02	0.02	0.07	<0.02	0.02	0.03	<0.02	0.01	0.13	0.08	0.10
Methyl chloroform	0.11	0.05	0.07	0.62	0.05	0.11	0.13	0.05	0.07	NA	NA	NA
Ethylene dibromide	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Ethylene dichloride	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Methyl tert-butyl ether	2.00	<0.50	0.91	5.70	<0.50	1.36	5.20	0.50	1.27	5.70	<0.50	0.73
Methylene chloride	1.40	<0.50	0.29	1.30	0.50	0.37	1.10	<0.50	0.33	8.00	<0.50	0.36
Perchloroethylene	0.22	0.03	0.09	0.22	0.01	0.06	0.42	0.01	0.09	3.20	<0.01	0.06
Toluene	3.20	0.40	1.30	7.20	0.40	2.46	8.20	0.50	1.86	14.3	<0.10	1.24
1,1,1-Trichloroethane	0.39*	0.05*	0.10*	0.44	0.12	0.21	0.16	0.07	0.10	4.42	<0.05	0.12
Trichloroethylene	0.10	<0.08	0.05	0.75	0.08	0.17	<0.08	<0.08	<0.08	0.75	<0.08	0.05
Vinyl chloride	<0.03	<0.03	<0.29	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30

* Based on 1998 data since 1999 or 2000 data not available.

Note:

NA = not available

ppb = parts per billion

Sources: BAAQMD and CARB in Design, Community & Environment 2002.

As can be seen from Table 8-4, the maximum measured toxic air contaminant concentrations in Mountain View are all lower than highest Bay Area values. Overall, the mean toxic air contaminant concentrations in Mountain View are similar to the mean concentrations for the overall Bay Area. However, several of the highest concentrations measured in the Bay Area were measured in Redwood City (methylene chloride) and San Jose (benzene).

8.4.2. NASA AMES RESEARCH CENTER

Operation of ARC currently generates air pollution emissions from aircraft operations and stationary sources. Table 8-5 summarizes emissions for ARC, Santa Clara County, and the Bay Area. The largest source of emissions at ARC is vehicular traffic. Existing NASA operations prior to new baseline projects generate an average of approximately 15,000 vehicle trips per day.

The 1996 emissions inventory represents the most recent annual emissions inventory available for the region. As shown in Table 8-5, the largest contributors of NO_x, CO, and ROG air pollutants in the region are mobile sources. The largest contributors to PM_{10} at ARC are aircraft operations. In the region, area-wide sources are the largest contributors to PM_{10}.

Table 8-5 Existing Air Pollutant Emissions Inventory For 2000

Source	Emissions in Metric Tons Per Day (Tons Per Day)			
	ROG	NO_X	CO	PM_{10}
Ames Research Center[1]				
Aircraft operations[2]	0.04 (0.04)	0.06 (0.07)	0.44 (0.49)	0.18 (0.20)
Stationary sources[2]	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)
Mobile sources[3]	0.15 (0.17)	0.27 (0.30)	1.58 (1.74)	0.07 (0.08)
Total	0.20 (0.21)	0.34 (0.38)	2.03 (2.24)	0.26 (0.29)
Santa Clara County				
Stationary sources	28.1 (31)	10.9 (12)	10.9 (12)	2.7 (3)
Area-wide sources	20.9 (23)	3.6 (4)	34.5 (38)	38.1 (42)
Mobile sources	69.0 (76)	94.4 (104)	597 (657)	3.6 (4)
Other	<1	<1	0.91 (1)	<1
Total	118 (130)	108.9 (120)	642 (708)	44.4 (49)
*				
Stationary sources	113.5 (125)	80.8 (89)	31.8 (35)	15.4 (17)
Area-wide sources	81.7 (90)	15.4 (17)	153.5 (169)	118.0 (130)
Mobile sources	289.7 (319)	410 (452)	2,418 (2,663)	19.1 (21)
Other	<1	<1	5.4 (6)	0.9 (1)
Total	485 (534)	506 (558)	2,609 (2,873)	153 (169)

1 Draft 1999 and 2010 Moffett Federal Airfield Operations Assumptions using BAAQMD inventory emissions factors.
2 CARB 2000 Estimated Annual Average Emissions.
3 MVEI7G emissions factors applied to 24,451 daily trips.

8.4.3. INDOOR AIR VAPOR INTRUSION

MACTEC Engineering and Consulting (MACTEC E & C) prepared a report on long-term indoor air quality monitoring of Buildings 15, 16, 17, 20, N-210, and N-243 to describe results of the sampling of the indoor air in the subject buildings for Volatile Organic Compounds (VOCs). These VOCs are contaminants associated with the shallow A aquifer underlying the NASA Ames Campus and the NASA Research Park (NRP) site. VOCs in groundwater can migrate, via soil air space, into buildings overlying a contaminated groundwater plume (USEPA, 2003). Methods exist for indirectly evaluating the extent to which the VOCs enter indoor air space (modeling based upon ground water or soil gas concentrations), however these methods suffer from uncertainties based upon limited availability of site-specific data and the overall predictive capabilities of the models (Johnson, 2003). Measurement of air concentrations most directly assesses the extent to which any of the VOCs are present in the indoor airspace. While measurement of air concentration eliminates uncertainties related to modeling, other factors must be accounted for if these results are to reflect exposure accurately. The measured concentration of any chemical in air can be due to a multitude of sources such as background air or indoor sources. In order to associate the measured indoor air concentrations with chemicals in the groundwater with a high degree of certainty, data on background chemical air concentrations, groundwater concentrations near the buildings in question, and surveys of chemicals and products used indoors will be collected and evaluated.

Measured air concentrations can vary significantly over time. Collection of a sufficient number of samples mitigates this variation by allowing the calculation of an Exposure Point Concentration (EPC) with high confidence that the EPC represents a reasonable upper bound on long-term exposure concentrations. Large numbers of samples collected on a daily or weekly basis also allow for comparisons between different analytes. Comparison of benzene, cis-1,2-dichloroethene, and trichloroethene results using 24-hr and 8-hr samples show that most of the detected benzene is likely due to mobile or other non-groundwater sources, whereas the detected cis-1,2-dichloroethene and trichloroethene results from vapor intrusion of contaminants in the underlying groundwater into the monitored buildings. Comparison of the Johnson and Ettinger model results for the rotunda of Building N-243 also support these conclusions.

Background corrected risks for all buildings except Building 17, based upon the measured air concentrations, are above the NASA point of departure of 1E-6. Except for location N-210-1, all background corrected risks were less than 1E-4. Non-carcinogenic Hazard Indices are less than 1 for all locations except N-210-1.

Data collected in Building 15 show that changes to a building's ventilation system operating parameters can have a positive effect on reducing indoor air concentrations. Further study and evaluation of the impact of ventilation system changes to indoor air concentrations are planned for Building 15 so that system can be optimized to provide the greatest reduction in contaminant concentrations while still providing appropriate levels of comfort for the building occupants. Additional study of Building N-210 is also planned.

Previous short-term indoor air studies have detected numerous VOCs in a number of buildings onsite, (HESE, 2001; HLA, 2000). The indoor air samples for these buildings were all single 8-hour or 24-hour integrated samples. Three rounds of soil surface flux samples were collected in the NRP. In general, the VOCs detected in the flux samples were similar to those detected in the indoor air. Groundwater monitoring has been conducted on the NASA Ames Campus and the NRP for approximately 15 years. In general, some of the chemicals detected in the indoor air and flux samples were also detected in the groundwater. However, there are numerous chemicals (such as vinyl chloride) that have been detected in the groundwater, but have not been found, or have only been found sporadically, above detection limits in either the flux or indoor air samples.

From the end of June 2003 through June 2004 over 1200 summa canister air samples were collected from buildings 15, 16, 17, 20, N-210, and N-243 on the ARC campus and NRP (Plate 1). In addition, during September and October 2004 samples were collected from Buildings 15 and N-210. All previous work plans and study results are available (MACTEC 2003a, b c, 2004a ,b ,c ,d ,e, f ,g ,h, i). As part of these prior studies, both 24- and 8-hr samples were collected from indoor building locations, as well as outdoor ambient and background sample locations. The study results indicated that indoor concentrations of cis-1,2-dichloroethene and trichloroethene in building N-210 were elevated relative to the outdoor ambient and background air samples. Results from the Building 15 September and October 2004 sampling also showed that modification to the ventilation system operating parameters could be effective in reducing these indoor concentrations (MACTEC 2004h, i).

As part of the long term indoor air quality (IAQ) study, two one-week sampling events were conducted in building N-210 during June 2004 (MACTEC 2004f, I; Neptune, 2005a). Additional follow-up samples were collected from N-210 in September and October of 2004 (*Neptune, 2005b*). Results for locations 210-1 and 210-6 (Plate 2) showed significantly elevated cis-1,2-dichloroethene and trichloroethene concentrations (MACTEC 2004i; Neptune 2005a, 2005b), but samples collected from the other locations in N-210 were similar to results in samples from some of the other buildings (15, 16, 17, and 20) collected during the same time periods. The source of the high concentrations at locations 210-1 and 210-6 (Plate 2) are thought to be either a result of poor airflow or of collecting samples adjacent to preferential vapor intrusion pathways. During the week of May 16, 2005, the EPA conducted a walk-through survey of Building N-210 using its Trace Atmospheric Gas Analyzer (TAGA) mobile laboratory. These results confirmed the previous summa canister samples (Neptune, 2005c). During two weeks in July 2005, 65 24-hr samples were collected from buildings N-210, N-211, N-239A, and N-259, as well as an out door ambient and background sample locations (Neptune 2006). These results clearly showed elevated trichloroethene concentrations in some of the breathing zone sample locations, as well as in some of the pathway sample locations.

In December 2005, modifications were made to the ventilation system serving N-210 rooms 143 and 145. The ventilation system in Rooms 143 and 145 was originally designed to use the sub-floor as a supply air plenum (Plate 4A). Any contaminants infiltrating the concrete foundation slab were thus swept into the breathing zone air. The modifications to the ventilation system made in December 2005 were designed to re-route fresh air through supply ducts in the ceiling and to bring fresh air into the sub-floor. The sub-floor fresh air system was designed so that the sub-floor floor space is always under negative pressure relative to the breathing zone working space. This negative-pressure differential prevents contaminants from infiltrating into the workspace of the rooms and building. A limited number of samples were collected in order to evaluate the effectiveness of the changes as quickly as possible, so that additional adjustments could be made if the results failed to show significant reductions in the breathing zone trichloroethene concentrations. Sample results showed a significant reduction of concentrations in rooms 143, and 145.

Measured concentrations were noticeably reduced at the breathing zone sampling locations (210-6, 210-8) during the January sampling because of the modifications made to the ventilation system in rooms 143 and 145. Concentrations were also significantly reduced at locations 210-1 and 210-10 due to the removal of the top of the display pedestal.

Additional confirmation samples were collected during February 2006 to provide more extensive evidence of the effect of the ventilation system changes in reducing indoor concentrations of the chemicals of potential concern (COPCs). Preliminary analysis of these results confirms the effectiveness of the ventilation system changes. These results will be detailed in a separate report.

Additional sampling occurred in 2007 (N-210, B-19, and B-16) and in February 2008 (B-3, B-16, B-12, B-510, B-154, B-566, B-107, and N-237). Elevated trichloroethene concentrations were found in B-107, and B-126; all other buildings had *de minimis* trichloroethene concentrations. Sampling occurred in May and July 2008 (B-126, B-107, B-20, and B-16). Trichloroethene concentrations in B-107 and B- 126 were less than the February results but still above the EPA Region 9 action level. The newly installed ventilation system in B-16 reduced trichloroethene concentrations below EPA Region 9 action levels.

Additional sampling occurred in March 2009 (B-566, B-107, B-126, B-15, N-237, and N-210). Results are not yet known.

8.5. ENVIRONMENTAL MEASUREMENTS

NASA and ARC have identified the following environmental measures that are designed to address potential air quality effects of operations and future development at ARC and are implemented to the extent feasible.

8.5.1. MITIGATION MEASURES

The NASA Ames Development Plan (NADP) Final Programmatic Environmental Impact Statement (FEIS) identified the following mitigation measures to address potential air quality impacts from build out of Mitigated Alternative 5 in the NADP

(Design, Community & Environment 2002). For a full discussion of impacts and mitigation measures related to the NADP, see the FEIS.

8.5.1.1. Mitigation Measure AQ-2

NASA and its partners would schedule construction to ensure that annual emissions of ozone precursors associated with project construction and operation do not exceed a cumulative total of 100 tons per year. This would apply over all years of project construction and operation or until an applicable State Implementation Plan that includes the project emissions is approved by EPA. Implementation of this mitigation is mandatory to comply with the Federal Clean Air Act.

8.5.1.2. Mitigation Measure AQ-3

Prior to the issuance of occupancy permits, operators of laboratories and disaster training facilities would be required to consult with the BAAQMD regarding possible permit requirements and emissions reduction equipment and to comply with BAAQMD's requirements.

8.5.1.3. Mitigation Measure AQ-4

Long-term residential uses would be avoided at areas located over high concentration zones of the Regional Plume in accordance with the Human Health Risk Assessment (HHRA) and the Environmental Issues Management Plan (EIMP), unless construction mitigation measures are implemented to reduce the risk of vapor intrusion.

8.5.1.4. Mitigation Measure AQ-5

NASA would review all planned uses in light of the findings of the HHRA to ensure that planned uses would not create unacceptable public health risks. Proposed uses would be moved if unacceptable risks were found that could not be mitigated to an acceptable level.

8.5.1.5. Mitigation Measure AQ-6a

Measures to control dust generation would reduce the impact associated with PM_{10} to a level of less-than-significant. The following measures, including all control measures recommended by the BAAQMD, would be incorporated into construction contract specifications and enforced by NASA. These measures include the following provisions.

- Use reclaimed water on all active construction areas at least twice daily and more often during windy periods. Watering is the single most effective measure to control dust emissions from construction sites. Proper watering could reduce dust emissions by over 75%.

- Cover all hauling trucks or maintain at least 0.6 meters (2 feet) of freeboard. Use dust-proof chutes as appropriate to load debris onto trucks during any demolition.
- Pave, apply reclaimed water three times daily, or apply (non-toxic) soil stabilizers on all unpaved access roads, parking areas, and staging areas at construction sites.
- Sweep daily (with water sweepers) all paved access roads, parking areas, and staging areas and sweep streets daily (with water sweepers) if visible soil material is deposited onto the adjacent roads.
- Hydro seed or apply (non-toxic) soil stabilizers to inactive construction areas (previously graded areas that are inactive for 10 days or more).
- Enclose, cover, water twice daily, or apply (non-toxic) soil binders to exposed stockpiles.
- Limit traffic speeds on any unpaved roads to 25 kilometers per hour (15 mph).
- Install sandbags or other erosion control measures to prevent silt runoff to public roadways.
- Replant vegetation in disturbed areas as quickly as possible.
- Install wheel washers for all exiting trucks, or wash off the tires or tracks of all trucks and equipment leaving the site.
- If necessary, install windbreaks, or plant trees/vegetative windbreaks at the windward side(s) of construction areas.
- Suspend excavation and grading activity when winds (instantaneous gusts) exceed 40 kilometers per hour (25 mph) and visible dust emission cannot be prevented from leaving the construction site(s).
- Limit areas subject to disturbance during excavation, grading, and other construction activity at any one time.
- Prior to disturbance (or removal) of materials suspected to contain asbestos, lead, or other toxic air contaminants, contact the BAAQMD.
- NASA would designate an Environmental Coordinator responsible for ensuring that mitigation measures to reduce air quality impacts from construction are properly implemented. This person would also be responsible for notifying adjacent land uses of construction activities and schedule.

8.5.1.6. Mitigation Measure AQ-6b

Measures to reduce emissions of nitrogen oxides and particulate matter from diesel fuel combustion during construction should be evaluated and implemented where reasonable and feasible. The following measures would reduce the impacts from construction fuel combustion.

- Properly maintain construction equipment. This measure would reduce emissions of ROG, NO_x, and PM_{10} by about 5%.
- Evaluate the use of available alternative diesel fuels and, where reasonable and feasible, use alternative diesel fuels. The CARB has verified reductions of NO_x by almost 15%, and particulate matter by almost 63%, from use of alternative diesel fuels. However, the use of these fuels may not be appropriate for all diesel equipment.
- Reduce construction traffic trips through Transportation Demand Management (TDM) policies and implementation measures.
- Reduce unnecessary idling of construction equipment and avoid staging equipment near or upwind from sensitive receptors such as on-site residences or daycare uses.
- Where possible, use newer, cleaner burning diesel-fueled construction equipment. The Environmental Coordinator would prohibit the use of equipment that visibly produces substantially higher emissions than other typical equipment of similar size.

8.5.1.7. Mitigation Measure AQ-7a

NASA would install air pollution devices, for example, particulate traps and oxidation catalysts, on construction equipment to the greatest extent that is technically feasible.

8.5.1.8. Mitigation Measure AQ-7b

NASA and its partners would develop and implement a Construction Emissions Mitigation Plan (CEMP) to ensure that the project would comply with the Federal Clean Air Act and further reduce emissions. The plan would include measures and procedures, sufficiently defined to ensure a reduction of nitrogen oxides, PM_{10}, and diesel particulate matter. The CEMP would be developed in consultation with EPA and BAAQMD. The CEMP would be evaluated by NASA and its partners on an annual basis to schedule construction ensuring that emissions of ozone precursors associated with project construction and operation would not exceed 91 tonnes (100 tons) per year and update measures to include new rules or regulations. NASA and its partners would consult with the BAAQMD on an annual basis during project construction to determine if additional air quality mitigations to reduce the project's air quality impact are warranted, and to take such additional air quality mitigation as is appropriate and reasonable, and in an expeditious manner. A CEMP coordinator, who would also act as a "Disturbance Coordinator," would be responsible for ensuring that measures included in the CEMP are implemented. This would be done through field inspections, records review, and investigations of complaints. At a minimum, the CEMP would include the following measures to reduce emissions from construction activities:

- Require that all equipment be properly maintained at all times.
- All construction equipment working on site would be required to include maintenance records indicating that all equipment is tuned to engine manufacturer's specifications in accordance with the time frame recommended by the manufacturer. All construction equipment would be prohibited from idling more than 5 minutes.
- Tampering with equipment to increase horsepower would be strictly prohibited.
- Include particulate traps, oxidation catalysts, and other suitable control devices on all construction equipment used at the site.
- Diesel fuel having a sulfur content of 15 ppm or less, or other suitable alternative diesel fuel, would be used unless such fuel cannot be reasonably procured in the market area.
- The CEMP would also ensure that construction-related trips are minimized through appropriate policies and implementation measures.
- The CEMP would address the feasibility on a biannual basis of requiring the use of reformulated or alternative diesel fuels.
- The CEMP Coordinator (or Environmental Coordinator) would prohibit the use of equipment that visibly produces substantially higher emissions than other typical equipment of similar size. The staging of three or more pieces of construction equipment near or just upwind from sensitive receptors such as residences or daycare uses would be prohibited.

8.5.1.9. Mitigation Measure AQ-7c

The CEMP would address the feasibility of requiring or encouraging the use of "cleaner" (lower emissions) construction equipment on an annual basis. For larger construction projects (projects greater than 9,290 square meters (100,000 square feet)), a percentage of the equipment would be required to be 1996 or newer. This would be determined as follows:

- If equipment is leased by the Contractor, then the percentage of 1996 or newer equipment would be maximized so that the total cost of leasing equipment would not exceed 110% of the average available cost for leased equipment.

- If equipment is owned by the Contractor, then the CEMP shall identify the minimum percentage of total horsepower for 1996 or newer equipment that should be used in construction. For the first year of construction, it shall be considered possible that 1996 or newer equipment shall makeup a minimum of 75% of the total horsepower, unless NASA and its partners can show the BAAQMD that it is not reasonable.

Chapter 9. Geology, Seismicity, Soils, and Mineral Resources

9.1. OVERVIEW

This chapter discusses the geologic and seismic setting of the ARC facility, describes the soils on the site, and provides an overview of mineral resources in the vicinity. It also summarizes the regulations relevant to geologic practice (including construction earthwork) at ARC, including the Alquist-Priolo Earthquake Fault Zoning Act, Seismic Hazards Mapping Act, Surface Mining and Reclamation Act, and relevant local laws and policies.

ARC is located in the seismically active Santa Clara Valley. Although the hazard of surface fault rupture at the site is probably low, the site could be subject to strong groundshaking because of an earthquake on any of the region's major faults, and could experience liquefaction. Environmental measures related to seismic hazards are described in Section 9.5, Environmental Measures.

Information regarding existing topography in Section 9.4, Existing Site Conditions, was obtained from the ARC Development Plan Final Programmatic Environmental Impact Statement (Design, Community & Environment 2002).

9.2. REGULATORY REQUIREMENTS

A variety of state and local regulations apply to geologic hazards and geologic practice in California. These include the state's Alquist-Priolo Earthquake Fault Zoning Act and Seismic Hazards Mapping Act, as well as county and city regulations that address geologic hazards as they relate to grading and construction activities. Portions of the federal Clean Water Act (described in Chapter 10, *Hydrology and Water Quality*) also impose controls on construction site best management practices (BMPs) during projects that require earthwork. The most important legislation relevant to mineral resource extraction is the state's Surface Mining and Reclamation Act.

The following sections provide an overview of the California regulatory context for geologic practice.

9.2.1. STATE REGULATIONS AND POLICIES

9.2.1.1. Alquist-Priolo Earthquake Fault Zoning Act

California's Alquist-Priolo Earthquake Fault Zoning Act (Public Resources Code Section 2621 et seq.), originally enacted in 1972 as the Alquist-Priolo Special Studies Zones Act and renamed in 1994, is intended to reduce the risk to life and property from surface fault rupture during earthquakes. The Alquist-Priolo Act prohibits the location of most types of structures intended for human occupancy across the traces of active faults and strictly regulates construction in the corridors along active faults (earthquake fault zones). It also defines criteria for identifying active faults, giving legal weight to terms such as *active*, and establishes a process for reviewing building proposals in and adjacent to Earthquake Fault Zones.

Under the Alquist-Priolo Act, faults are zoned, and construction along and across them is strictly regulated if they are "sufficiently active" and "well-defined." A fault is considered *sufficiently active* if one or more of its segments or strands shows evidence of surface displacement during Holocene time (defined for purposes of the act as referring to approximately the past 11,000 years). A fault is considered *well defined* if its trace can be clearly identified by a trained geologist at the ground surface or in the shallow subsurface using standard professional techniques, criteria, and judgment (Hart and Bryant 1997).

9.2.1.2. Seismic Hazards Mapping Act

Like the Alquist-Priolo Act, the Seismic Hazards Mapping Act of 1990 (Public Resources Code Sections 2690-2699.6) is intended to reduce damage resulting from earthquakes. While the Alquist-Priolo Act focuses on surface fault rupture, the Seismic Hazards Mapping Act addresses other earthquake-related hazards, including strong groundshaking, liquefaction, and seismically induced landslides. Its provisions are similar in concept to those of the Alquist-Priolo Act. The state is charged with identifying and mapping areas at risk of strong groundshaking, liquefaction, landslides, and other corollary hazards, and cities and counties are required to regulate development within mapped Seismic Hazard Zones.

Under the Seismic Hazards Mapping Act, permit review is the primary mechanism for local regulation of development. Specifically, cities and counties are prohibited from issuing development permits for sites within Seismic Hazard Zones until appropriate site-specific geologic and/or geotechnical investigations have been carried out and measures to reduce potential damage have been incorporated into the development plans.

9.2.1.3. Surface Mining and Reclamation Act

The principal legislation addressing mineral resources in California is the Surface Mining and Reclamation Act of 1975 (SMARA) (Public Resources Code Sections 2710–2719), which was enacted in response to land use conflicts between urban growth and essential mineral production. SMARA provides a comprehensive surface mining and reclamation policy to encourage the production and conservation of mineral resources while ensuring that adverse environmental effects of mining are prevented or minimized, that mined lands are reclaimed and residual hazards to public health and safety are eliminated, and that consideration is given to recreation, watershed, wildlife, aesthetic, and other related values.

SMARA provides for the evaluation of an area's mineral resources using a system of Mineral Resource Zone (MRZ) classifications that reflect the known or inferred presence and significance of a given mineral resource. The MRZ classifications are based on available geologic information (including geologic mapping and other information on surface exposures, drilling records, and mine data) and on socioeconomic factors, such as market conditions and urban development patterns. The MRZ classifications are defined as follows:

- MRZ-1: Areas where adequate information indicates that no significant mineral deposits are present, or where it is judged that little likelihood exists for their presence
- MRZ-2: Areas where adequate information indicates that significant mineral deposits are present, or where it is judged that a high likelihood for their presence exists
- MRZ-3: Areas containing mineral deposits, the significance of which cannot be evaluated from available data
- MRZ-4: Areas where available information is inadequate for assignment into any other MRZ

SMARA governs the use and conservation of a wide variety of mineral resources. However, certain activities and resources are exempt from the provisions of SMARA, including excavation and grading conducted for farming, some types of construction, and recovery from flooding or other natural disaster. Solar extraction of salt and related minerals from sea and bay waters is also exempt from SMARA governance.

9.2.1.4. California Building Standards Code

The California Building Standards Code (CBSC) (Title 24, California Code of Regulations [CCR]) embodies the state's minimum standards for structural design and construction. CBSC is based on the widely used Uniform Building Code (International Conference of Building Officials 1997), as modified for California conditions. Key modifications provide additional stringency for mitigation of seismic hazards through appropriate design and construction.

CBSC provides a comprehensive set of standards for all aspects of construction. Chapters in the code with particular relevance to geologic and geotechnical practice include those addressing excavation, grading, and fill placement; foundation investigations and foundation design; and seismic design/seismic hazard mitigation.

9.2.2. LOCAL REGULATIONS AND POLICIES

Although ARC is federal property and as such is constitutionally exempt from the requirements of local plans, NASA attempts to meet local guidelines and standards whenever possible in order to maintain a cooperative relationship with the County of Santa Clara and the neighboring cities of Mountain View and Sunnyvale (see related discussion in Chapter 4, *Land Use*). The following sections describe local regulations and policies with particular relevance to geology and geologic practice.

9.2.2.1. Grading Policies and Permits

Permits for excavation are granted through the Facility Engineering branch at NASA Ames Research Center. An excavation permit from Facility Engineering shall be obtained prior to conducting any excavation activities at the center.

9.2.2.2. Santa Clara County Mineral Resources Policies

The current Santa Clara County General Plan (County of Santa Clara 1994) contains a number of policies that recognize the importance of the county's mineral resources and establish a planning framework to ensure that they remain available in the future. Several of the policies are countywide, as summarized below.

- Countywide Resource Conservation Policy C-RC 44: Recognizes the need to ensure continued availability of mineral resources to meet long-term demand
- Countywide Resource Conservation Policy C-RC 45b: Recognizes the need to preserve economically important mineral deposits (particularly construction aggregate) and access routes, with the aim of maintaining and supplying current and future demand
- Countywide Resource Conservation Policy C-RC-46: Establishes the goal of protecting regionally significant mineral resource sites and access routes from incompatible land uses and development that would preclude or unnecessarily limit resource availability

Additional policies apply to the county's unincorporated rural areas, as follows.

- Rural Unincorporated Area Resource Conservation Policy R-RC 67: Establishes the goal of ensuring that local mineral resources are recognized for their importance to the local, regional, and state economies
- Rural Unincorporated Area Resource Conservation Policy R-RC 70: Identifies the need to consider the importance of mineral resources to their market region as a whole when making land use decisions involving mineral resource areas of state or regional significance

- Rural Unincorporated Area Resource Conservation Policy R-RC 71: Recognizes the need to identify additional mineral resource areas besides those that are currently designated by the State of California in order to augment diminishing supplies available from existing quarries

9.3. REGIONAL SETTING

9.3.1. TOPOGRAPHY

The ARC site is located on nearly flat topography at the north end of the Santa Clara Valley, a gently sloping, northwest-trending depression bounded by the Santa Cruz Mountains to the west and south, and the Diablo Range to the east. About 15 miles wide at its northern end along the margin of San Francisco Bay, the valley narrows to a width of slightly more than 2 miles at its southern end. It is part of a regionally extensive topographic depression that includes San Francisco Bay, as well as the Petaluma, Sonoma, and Napa valleys to the north (Norris and Webb 1990). Topography in the Santa Clara Valley, as in the rest of the Bay Area, is largely controlled by strands of the San Andreas Fault system.

Current elevations on the valley floor range from mean sea level (MSL) along the margin of San Francisco Bay to about 200 feet above sea level in the south near the intersection of State Route 82 and U.S. Highway 101 (US-101). Between 1932 and 1968, a large portion of the Santa Clara Valley experienced marked subsidence because of groundwater overdraft; subsidence rates in some areas approached 0.30 meter (1 foot) per year. In response, the Santa Clara Valley Water District established a program in the late 1960s to create numerous surface reservoirs that would promote artificial recharge of aquifers. Combined with increased reliance on imported sources of supply and control of groundwater pumping rates, this program has been successful in raising the water table, and subsidence is no longer considered a serious problem (Santa Clara Valley Water District 2001).

9.3.2. GEOLOGY

Bedrock exposed in the Santa Cruz Mountains to the west of the Santa Clara Valley includes Mesozoic Franciscan Complex sandstone and marine sedimentary rocks of Miocene age. To the east, the core of the Diablo Range uplift is also composed of Franciscan Complex rocks (sandstone, chert, and ultramafic rocks) overlain by and faulted against Miocene marine and terrestrial sedimentary rocks. Low hills situated where the Santa Clara Valley narrows along US-101 consist of Franciscan chert, ultramafic rocks, and sandstone. Both the Santa Cruz Mountains and Diablo Range are flanked by extensive aprons of Quaternary alluvial fan deposits recording uplift and erosional dissection of the ranges (Wagner et al. 1990).

The Santa Clara Valley formed as a down-dropped block between two major faults: the San Andreas Fault to the west and the Hayward Fault to the east. Sediments filling the valley depression include alluvial fan and fluvial deposits that interfinger to the north (toward San Francisco Bay) with estuarine "bay mud" deposits. Surface geologic maps show alluvial fan deposits extending northeast approximately to US-101. North of US-101, finer-grained floodplain deposits predominate, with the Bay itself fringed by mud. To the south, the transition from finer-grained interfluvial deposits to coarser alluvial fan sediments is approximately coincident with a steepening of the present topographic slope near US-101 (Helley and Brabb 1971; Iwamura 1980).

The upper 75 meters (250 feet) of the valley fill comprises four separate stratigraphic units of Quaternary (Pleistocene and Holocene) age. They include "bay muds" (clay and silty clay units deposited in an estuarine setting in San Francisco Bay) and fluvial and alluvial units. Pleistocene units are typically partially consolidated, and Holocene units are unconsolidated (ARC 2003). A marked unconformity separates the Upper Pleistocene units of the Santa Clara Valley from overlying Holocene strata (Helley 1990). Complex interfingering relationships between estuarine bay muds and alluvial/fluvial facies likely record sea level fluctuations (ARC 2003).

McCully, Frick, and Gillman (1987) divide the bay muds into older and younger subunits. Their "older bay mud" is as much as 45 meters (150 feet) thick and is further subdivided into lower and upper informal units. The lower unit consists of light gray silty clay and the upper unit is dominated by sand and gravel, but contains interbeds of clay, silty clay, and clayey sand. The older bay mud was primarily deposited in fluvial and alluvial fan settings. The "younger bay mud" ranges from 5 meters (15 feet) to 15 meters (50 feet) thick. It consists primarily of dark gray to dark brown organic clay containing minor peat and clayey sand and is interpreted as estuarine and marine deposits. Local sand lenses may represent stream deposits. Holocene alluvium consists of interbedded sand and gravel with lesser silt and clay. These strata are interpreted as recording fluvial and alluvial deposition (Helley 1990)

9.3.3. GEOLOGIC HAZARDS

9.3.3.1. Seismicity

The Santa Clara Valley is located in one of the most seismically active regions of the United States. Seismic activity in the area has occurred mostly along the San Andreas Fault, including the great San Francisco earthquake of 1906 and the Loma Prieta earthquake of 1989. At least 10 other earthquakes with magnitudes greater than 6.0 on the Richter scale have occurred in the Bay Area in the past 100 years. The maximum credible earthquake or design basis for the San Andreas Fault is magnitude 8.3. For the Hayward and Calaveras faults, the maximum credible earthquake is magnitude 7.5. There have been important quakes on other faults, notably the Hayward.

9.3.4. TOPOGRAPHY

ARC is located approximately 1 mile south of the San Francisco Bay margin in an area that historically supported tidal salt marsh and mud flats. The former salt ponds are now part of the USFWS South Bay Salt Pond Restoration Project. Consistent with the historic loss of these habitats baywide, the large area north and northeast of ARC is now diked and consists of evaporation ponds that were formerly used for commercial salt production. The northernmost portion of the ARC site is located within the 100-year tidal floodplain.

Topography at the ARC site is nearly flat. From north to south, the site rises at a slope generally less than 1%, ranging in elevation from approximately 0.6 meter (2 feet) below MSL near its northern boundary to approximately 10 meters (33 feet) above MSL in the south. Elevation change from east to west is minimal. The principal topographic features on the site are low levees constructed to protect roads and structures from Bay waters during high storm tides.

Between 1932 and 1969, the area that is now the ARC site experienced 1.5 to 2 meters (4.9 to 6 feet) of subsidence because of groundwater overdraft. As described in Regional Setting above, efforts to arrest subsidence through artificial groundwater recharge and improved stewardship have largely been successful. Fluctuation in groundwater levels during wet or dry years, which might previously have threatened buildings, is now unlikely to cause any structural damage. However, structures such as long utility lines and stormwater channels that are more sensitive to local subsidence are designed to minimize any problems (California Air National Guard 1997 in Design, Community & Environment 2002; ARC 2003).

9.3.5. GEOLOGY

Bedrock underlying the ARC site is believed to belong to the Franciscan Formation of late Jurassic age. Bedrock at the site is overlain by 460 meters (1,495 feet) or more of alluvium and bay muds of Pleistocene and Holocene age (Iwamura 1980).

9.3.6. SEISMICITY

No faults recognized as active by the State of California or the current CBSC traverse the ARC site, and the ARC site is not within any Earthquake Fault Zone identified by the state pursuant to the Alquist-Priolo Earthquake Fault Zoning Act. Consequently, surface rupture is considered unlikely to affect the site. Nonetheless, because of its location, the site could experience strong groundshaking generated by earthquakes on any of several faults in the region (San Andreas, Hayward, Calaveras)/

9.3.7. SOILS

Surface soils along the San Francisco Bay margin typically consist of silt and clay. The ARC site is located on soils assigned to Sunnyvale silty clay, Alviso clay, Bayshore clay loam, and Pacheco loam classification (U.S. Department of Agriculture 1975 in ARC 2003). However, soils at ARC have been substantially altered by land uses during the past 100 years. The majority of the site's upland areas and portions of its wetlands now support artificial fill and/or impervious cover overlying native soils. Native soil is typically exposed only in the diked brackish marshes and open grasslands on the northwest portion of the site, and even in these areas some alterations related to land use have occurred. For instance, diking and draining have altered the surface and shallow groundwater hydrology of the sites and eliminated the natural tidal influence on soils. Nonetheless, as discussed in detail in Chapter 12, *Vegetation and Wetlands*, the soils remain saline and this salinity maintains salt marsh vegetation in areas that are now removed from tidal influence.

The following sections provide additional detail on Sunnyvale silty clay, Alviso clay, Bayshore clay loam, Pacheco loam, and artificial fill materials, as well as Kitchen midden deposits that may be present in some areas.

9.3.7.1. Sunnyvale Silty Clay, Drained

About 70% of the ARC site is situated on Sunnyvale silty clay, drained, including the **developed southern and central portions of the site. Sunnyvale silty clay typically forms** in low-level positions on alluvial plains. The surface soil consists of 28 to 45 centimeters (11 to 18 inches) of moderately alkaline dark gray calcareous silty clay. The subsoil consists of 65 to 80 centimeters (26 to 32 inches) of light gray and gray strongly calcareous silty clay. The substratum is mottled light gray slightly calcareous silty clay alluvium. Sunnyvale silty clay is not included in the National Hydric Soil Series List; however, it exhibits hydric characteristics at ARC (Design, Community & Environment 2002).

Sunnyvale silty clay has a water storage capacity of 23 to 25 centimeters (9 to 10 inches). Runoff rates are very slow and erosion is negligible. Permeability of the subsoil is slow, and ponding may occur in winter months.

Sunnyvale silty clay is highly expansive. The inherent fertility of this soil is high. However, the choice of plants is limited because the soil drains poorly and the soil textures are fine or very fine.

9.3.7.2. Alviso Clay

The north portion of the Eastside/Airfield area, which represents about 25% of the ARC site, is situated on Alviso clay. Alviso clay typically forms on tidal flats and may be subject to flooding at high tides, where it is not protected by levees. The surface soil consists of 15 to 25 centimeters (6 to 10 inches) of neutral to moderately alkaline dark gray clay. A layer of organic material is locally present in the upper few centimeters of the surface soil. The subsoil consists of 75 to 100 centimeters (30 to 40 inches) of moderately alkaline gray silty clay. The substratum is gray silty clay overlying layered basin sediments. Alviso clay is included on the National Hydric Soil Series List (U.S. Soil Conservation Service 1968 in ARC 2003).

Alviso clay is very poorly drained and has a water storage capacity of 10 to 20 centimeters (4 to 8 inches). Runoff rates are very slow and erosion is negligible. The subsoil is slowly permeable, so ponding may occur. The water table is typically 0.3 to 1 meter (1 to 3 feet) below the ground surface.

Alviso clay is highly expansive. The inherent fertility of this soil is very low. The choice of plants is further limited by soil moisture, and by salinity and/or alkalinity.

9.3.7.3. Bayshore Clay Loam

The east edge and southwest corner of the ARC site, comprising about 3% of ARC's total area, are situated on Bayshore clay loam. Bayshore clay loam typically forms in low-level positions on alluvial plains. The surface soil consists of 28 to 40 centimeters (11 to 16 inches) of dark gray calcareous clay loam, overlying subsoil consisting of 53 to 93 centimeters (21 to 37 inches) of light gray and white strongly calcareous clay loam. The substratum consists of light gray gravelly loam.

Bayshore clay loam is poorly drained and has a water storage capacity of 20 to 25 centimeters (8 to 10 inches). Runoff rates are very slow and erosion is negligible. The subsoil is moderately slowly permeable.

Bayshore clay loam is moderately expansive. The inherent fertility of this soil is very low. The choice of plants is further limited by soil moisture, and by salinity and/or alkalinity.

9.3.7.4. Pacheco Loam, Clay Substratum

The western portion of the Bayview area, along Stevens Creek, is situated on Pacheco loam, clay substratum. The area underlain by Pacheco loam represents about 3% of the ARC site. The surface soil consists of 35 to 45 centimeters (14 to 18 inches) of moderately alkaline grayish brown fine sandy loam, loam, and clay loam. The subsoil consists of 45 to 63 centimeters (18 to 25 inches) of moderately alkaline mottled light gray loam. The substratum is clay.

Pacheco loam is poorly drained and has a water storage capacity of 10 to 20 centimeters (4 to 8 inches). Runoff rates are very slow and erosion is negligible. The subsoil is slowly permeable, and the water table may be within 0.6 meter (2 feet) of the surface during and following the wet season.

Pacheco loam is moderately expansive. The inherent fertility of this soil is moderate. The choice of plants is limited by soil moisture.

9.3.7.5. Artificial Fill

Developed portions of the ARC site, including the golf course, levees, and areas where buildings are present, are underlain by artificial fill consisting of native soil mixed with gravel, concrete, asphalt, and other materials. Characteristics of the fill differ from site to site, depending on the native soil, added materials, and degree of compaction, which varies with land use. For instance, the golf course was constructed on fill that resembles Sunnyvale and Alviso clays. Fill underlying runway areas, roads, and levees consists of basin clays mixed with gravel and is substantially compacted. All fills for roads, buildings, airfields, and runways are engineered (Olliges 2004).

9.3.7.6. Kitchen Middens

There are two areas at Ames Research Center, one on the northern end of the Bay View area and one in the middle of the Eastside/Airfield area, where soils are classified as Kitchen middens (Design, Community & Environment. 2002). Kitchen middens represent areas that were used as cooking or camping sites by Native Americans. The native soil material is typically dark gray, friable, calcareous loam or clay loam, mixed with ashes, charcoal, shell fragments, stones, and sparse bones or bone fragment.

Kitchen middens typically occur on nearly level to gently sloping topography, as at ARC. In most places, native soil underlies the middens at depths of 0.3 to 0.6 meter (1 to 2 feet).

Kitchen middens are well drained and have a water storage capacity of 20 to 25 centimeters (8 to 10 inches). Runoff rates are moderate and erosion is not usually a hazard. However, permeability is slow and heavy rains can lead to localized ponding and/or flooding.

Fertility is moderate and the rooting zone is very deep. Elsewhere in the Santa Clara Valley, kitchen middens support irrigated row crops, prunes, apricots, walnuts, and pasture.

9.4. ENVIRONMENTAL MEASURES

9.4.1. Measures for Seismic Safety

To the extent feasible, structures are sited and constructed to minimize the possibility of serious structural damage, human injury, and loss of life in earthquakes up to and including the design basis event. All new construction is required to meet the seismic requirements of the current CBSC. In addition, many older buildings on the site, such as Hangar 3 and Building N-210, have been or will be seismically upgraded. NASA has committed to ensuring that all future rehabilitation of historic structures within the Shenandoah Plaza Historic District follows the *Guidelines for the Rehabilitation of Historic Structures* developed by the Architectural Resources Group for NASA, and that all rehabilitation of historic buildings within the ARC site follows the Secretary of the Interior's *Guidelines for the Rehabilitation of Historic Structures* in order to maximize seismic safety while minimizing effects on the integrity of any National Register-listed or eligible structure.

Hazards from seismically induced settlement and liquefaction are evaluated for all new major structures. NASA Ames requires the preparation of a soils report for all new construction, and ensures that the recommendations of these studies are incorporated into building design and construction.

Certain pipelines crossing the site are very prone to damage from seismic activity. Disruption of the high-pressure air system that serves several buildings would pose a threat to safety. Damage to a utility or fuel line (for example, a break in a sewer or natural gas main) could be reasonably controlled by pipeline shutdown, prompt cleanup, and repair.

9.4.2. SOILS MEASURES

Erosion prevention measures are implemented during all construction and grounds maintenance activities.

In addition, as discussed in Measures for Seismic Safety above, all new construction will include geotechnical analyses of proposed sites to determine the design and construction measures necessary to address the risk of structural damage from expansive and/or corrosive soils.

9.4.3. NASA BEST MANAGEMENT PRACTICES (BMPS)

NASA Ames has adopted BMPs that apply to all activities conducted on the site. The following standard NASA BMPs address sediment and erosion control.

9.4.3.1. Storm Water BMPs

This BMP includes a description of all sediment and erosion control activities. This may include the planting and maintenance of vegetation, diversion of run-on and runoff, placement of sandbags, and silt screens or other sediment control devices. Any site where soils are exposed to water and wind can have soil erosion and sedimentation problems. Erosion is a natural process in which soil and rock materials are loosened and removed. Sedimentation occurs when soil particles are suspended in surface runoff or wind and are deposited in streams and other water bodies.

Human activities can accelerate erosion by removing vegetation, compacting or disturbing the soil, changing natural drainage patterns and by covering the ground with impermeable surfaces (pavement, concrete, and buildings). When the land surface is developed or "hardened" in this manner, storm water can not seep into or "infiltrate" the ground. As a result, larger amounts of water move more quickly across the site, which can carry more sediment and other pollutants to creeks and streams. Because the vegetation primarily consists of marshlands and grasslands, soil erosion prevention is not required in many areas of ARC. However, erosion prevention measures are considered during any construction and / or grounds maintenance activities.

Targeted constituents in this BMP are:

- Sediment
- Heavy Metals
- Toxic Materials

This Best Management Practice is applicable to all building, construction, and landscaping activities at Ames Research Complex.

The requirements of this BMP are the following:

- Identify areas, which, due to topography, activities, or other factors, have a high potential for significant soil erosion, and identify structural, vegetative, and / or stabilization measures used to limit erosion
- Retain as much vegetation (plants) onsite as possible
- Minimize the time that soil is exposed. Water exposed areas to control dust
- Prevent runoff from flowing across disturbed areas (divert the flow to vegetated areas)
- Stabilize the disturbed soils as soon as possible by planting vegetation or hydroseeding
- Slow down the runoff flowing across site (regrading, silt fences, planting)
- Provide drainage ways for the increased runoff (use grassy swales rather than concrete drains)
- Remove sediment from storm water run-off before it leaves the site
- For large piles of soil where tarps or other covers are not feasible, place filtering media (e.g. straw bales, rocks, silt fences, etc.) around the base of each pile or at the storm drain inlet to remove these materials from rainwater run-off

Chapter 10. Hydrology and Water Quality

10.1. OVERVIEW

This chapter describes water quality, including surface water drainage, stormwater management, groundwater hydrology, and surface and groundwater quality.

ARC is located in the Stevens Creek watershed, a tributary to South San Francisco Bay, but historic surface water drainage patterns at the site have been substantially modified to manage runoff from impervious surfaces. Stormwater from the west side of the site is impounded at the north end of ARC, with excess peak runoff occasionally pumped into Stevens Creek, which flows to the bay. Stormwater from the east side of the campus discharges to the Moffett Channel then to Guadalupe Slough and ultimately into the bay.

ARC is within the Santa Clara Valley groundwater basin, the largest of the 31 groundwater basins that ring San Francisco Bay. Groundwater beneath the site has been substantially affected by the Middlefield-Ellis-Whisman (MEW) Superfund site in neighboring Mountain View, and by chemical spills and releases associated with U.S. Navy and NASA operations. Consequently, NASA and the U.S. Navy are currently working with the private companies identified as responsible for the bulk of MEW contamination to remediate area groundwater. The site, north of Highway 101, currently supports several hundred groundwater-monitoring wells, approximately 20 groundwater extraction wells and three groundwater treatment operations.

10.2. REGULATORY REQUIREMENTS

10.2.1. FEDERAL REGULATIONS

10.2.1.1. Clean Water Act

The Clean Water Act (CWA) is the primary federal law that protects the quality of the nation's surface waters, including lakes, rivers, and coastal wetlands. It operates on the principle that all discharges into the nation's waters are unlawful unless specifically authorized by a permit; permit review is the CWA's primary regulatory tool.

The sections of the CWA most relevant at ARC are Section 303 (Water Quality Standards and Implementation Plans) and Section 402 (National Pollutant Discharge Elimination System [NPDES]). The EPA has delegated its authority to implement and enforce the provisions of these sections to the individual states. In California, the nine Regional Water Quality Control Boards (RWQCB) under the auspices of the State Water Resources Control Board (SWRCB) enforce the provisions. Additional information on the requirements imposed by CWA Sections 303, 401, and 402 is provided in Porter-Cologne

10.2.1.2. Drinking Water Act

The Safe Drinking Water Act of 1974 (Public Law 93-523) is the principal federal law that protects the quality of the nation's drinking water. It empowers EPA to set drinking water standards and to oversee the water providers (cities, water districts, and agencies) that actually implement those standards. It also includes provisions for the protection of surface waters and wetlands, in support of drinking water quality.

In California, EPA delegates some of its implementation authority to the California Department of Health Services' Division of Drinking Water and Environmental Management (DHS). DHS administers a wide range of regulatory programs that include components aimed at drinking water quality and safety, such as:

- permitting for water well installation
- potable water supply monitoring requirements for public drinking water systems and new domestic wells
- regulations for septic and sewer systems
- regulations governing generation, handling, and discharge/disposal of hazardous materials and wastes
- regulations for underground storage tanks (USTs) and solid waste disposal facilities

The following sections of the Code of Federal Regulations (CFR) contain key provisions of the Safe Drinking Water Act.

- 40 CFR, Part 141 (National Primary Drinking Water Regulations) and 40 CFR, Part 142 (National Primary Drinking Water Regulations Implementation): The National Primary Drinking Water Regulations are fundamental health-based standards for drinking water purity. They are enforced nationwide.
- 40 CFR, Part 143 (National Secondary Drinking Water Regulations) The National Secondary Drinking Water Regulations establish standards for drinking water contaminants that primarily affect aesthetic qualities such as taste, odor, and clarity, although they may have health implications at high concentrations. The secondary drinking water standards are not federally enforceable but are intended as guidelines that the states may adopt on a discretionary basis. California has elected to enforce these standards.

10.2.1.3. Floodplain Regulations

Federal Flood Insurance Program

Alarmed by the increasing costs of disaster relief, Congress passed the National Flood Insurance Act in 1968 and the Flood Disaster Protection Act in 1973. The intent of these acts was to reduce the need for large publicly funded flood control structures and decrease disaster relief costs by restricting development on floodplains.

The Federal Emergency Management Agency (FEMA) administers the National Flood Insurance Program (NFIP) to provide subsidized flood insurance to communities that comply with FEMA regulations limiting development on floodplains. FEMA issues Flood Insurance Rate Maps (FIRMs) delineating flood hazard zones for communities participating in the NFIP.

Federal Executive Orders 11988 and 11990

Executive Order 11988 (Floodplain Management) and Executive Order 11990 (Protection of Wetlands) addresses floodplain issues related to public safety, conservation, and economics. It generally requires federal agencies constructing, permitting, or funding a project to:

- avoid incompatible floodplain and wetland development
- be consistent with the standards and criteria of the NFIP
- restore and preserve natural and beneficial floodplain and wetland values

10.2.2. STATE REGULATIONS

10.2.2.1. Porter-Cologne Act and State Implementation of CWA Requirements

Overview

The Porter-Cologne Water Quality Control Act, passed in 1969, provides state-level requirements promulgated in the federal CWA. It established the SWRCB and divided the state into nine regions, each overseen by an RWQCB. The SWRCB is the primary state agency responsible for protecting the quality of the state's surface and groundwater supplies, but much of its daily implementation authority is delegated to the nine RWQCBs. ARC is under the jurisdiction of the San Francisco Bay RWQCB.

Consistent with the federal CWA, the Porter-Cologne Act provides for the development and periodic review of water quality control plans (basin plans) that designate beneficial uses of California's major rivers and groundwater basins and establish narrative and numerical water quality objectives for those waters (San Francisco Regional Water Quality Control Board 1995). The purpose of water quality objectives is to protect designated beneficial uses for each basin's waters. To ensure currency, basin plans must be updated every 3 years.

Basin plans are primarily implemented by using the NPDES permitting system to regulate waste discharges so that water quality objectives are met. Basin plans provide the technical basis for determining waste discharge requirements, taking enforcement actions, and evaluating clean water grant proposals.

As described above, the Porter-Cologne Act also assigns responsibility for implementing CWA Sections 401-402 and 303(d) to the SWRCB and RWQCBs.

Basin Plan Beneficial Uses and Water Quality Objectives for Water Bodies at NASA Ames

Existing and potential beneficial uses of surface and groundwater in the vicinity of ARC are identified in the Water Quality Control Plan for the San Francisco Bay Basin (Basin Plan). Beneficial uses of the San Francisco Bay Basin, Stevens Creek, Guadalupe Slough, and the Santa Clara Valley groundwater basin are shown in Table 10-1.

Table 10-1 Beneficial Uses of Surface and Ground Waters at NASA Ames

Water Body	Beneficial Use
Wetland Areas of South San Francisco Bay	estuarine habitat fish migration ocean, commercial, and sport fishing preservation of rare and endangered species contact and noncontact water recreation saltwater habitat fish spawning wildlife habitat
South San Francisco Bay	ocean, commercial, and sport fishing estuarine habitat industrial service supply fish migration navigation preservation of rare and endangered species contact and noncontact water recreation shellfish harvesting wildlife habitat potential fish spawning
Stevens Creek	cold freshwater habitat freshwater replenishment fish migration contact and noncontact water recreation warm freshwater habitat wildlife habitat potential fish spawning
Santa Clara Valley Groundwater Basin	municipal and domestic supply industrial process supply industrial service supply agricultural supply
Source: San Francisco Bay Basin Water Quality Control Plan (California RWQCB 2005).	

Table 10-2 shows the water quality standards that apply to the San Francisco Bay Basin, including Stevens Creek and Guadalupe Slough, in support of these water bodies' designated beneficial uses.

Table 10-2. Surface Water Quality Standards: San Francisco Bay, Stevens Creek, and Guadalupe Slough

Parameter	Standard
pH	6.5 to 8.5 pH Normal ambient level changes of < 0.5 units
Dissolved oxygen	5.0 mg/L (south San Francisco Bay) 7.0 mg/L (Stevens Creek and Guadalupe Slough)
Fecal coliform	South San Francisco Bay Median = 50 per 100 ml (five consecutive samples) Maximum <400 per 100 ml (per sample) Stevens Creek and Guadalupe Slough log mean <20 per 100 ml (= five samples, 30-day period) = 10% of samples <400/100 ml (30-day period)
Oil and grease	No visible film or coating on the surface that impacts beneficial uses
Temperature	San Francisco Bay Beneficial uses must be maintained Maximum not to exceed receiving waters by more than 20° F (11.1° C) Stevens Creek and Guadalupe Slough Maximum not to be increased by more than 5° F (2.8° C) above receiving waters

mg/L = milligrams per liter
ml = milliliter
Source: California RWQCB 2005

The Basin Plan specifically states that the water quality objectives for the Santa Clara Valley groundwater basin are to achieve the following concentrations for waters that provide municipal or domestic water supply.

Taste or odor-producing substances should be present at levels that do not cause nuisance or adversely affect beneficial uses. At a minimum, groundwater designated for use as domestic or municipal supply should not contain concentrations in excess of the secondary maximum contaminant levels (MCLs) specified in Tables 10-3 and 10-4.

Table 10-3 . Secondary Maximum Contaminant Levels

Chemical or Characteristic	Secondary MCL
Aluminum (Aluminum also has a primary MCL of 1 mg/L)	0.2
Color	15 units
Copper	1.0
Corrosivity	Non-corrosive
Foaming agents (MBAs)	0.5
Iron	0.3
Manganese	0.05
Methyl tertiary butyl ether (Also has an action level of 0.013 mg/L and a proposed primary MCL of 0.013 mg/L).	0.005
Odor threshold	3 units
Silver	0.1
Thiobencarb (Bolero) (Also has a primary MCL of 0.07 mg/L).	0.001
Turbidity	5 units
Zinc	5.0
Notes: Consumer acceptance limits All values are in milligrams per liter (mg/L), unless otherwise noted.	

Table 10-4 Secondary Maximum Contaminant Level Ranges

	Secondary MCL Ranges		
Constituent	**Recommended**	**Upper**	**Short Term**
Total Dissolved Solids	500	1,000	1,500
Or			
Specific conductance, micromhos	900	1,600	2,200
Chloride	250	500	600
Sulfate	250	500	600

- Coliform organisms should be present at levels below a “most probable number” (MPN) concentration of 1.1 (1.1 MPN) per 100 milliliters, measured as the median concentration over a 7-day period.
- Chemical constituents should be present below the MCLs summarized in Tables 10-5 and 10-6.

Table 10-5 Maximum Contaminant Levels for Inorganic Chemicals

Chemical	Maximum Contaminant Level (mg/L)
Aluminum	1
Antimony	0.006
Arsenic	0.05
Asbestos	7 MFL*
Barium	1
Beryllium	0.004
Cadmium	0.005
Chromium	0.05
Cyanide	0.2
Fluoride	2
Mercury	0.002
Nickel	0.1
Nitrate (as NO_3)	45
Nitrate + Nitrite (sum as nitrogen)	10
Nitrite (as nitrogen)	1
Selenium	0.05
Thallium	0.002

*MFL = million fibers per liter; MCL for fibers exceeding 10 micrometers in length.
mg/L = micrograms per liter.

Table 10-6 Maximum Contaminant Levels for Organic Chemicals

Chemical	Maximum Contaminant Level (mg/L)
(a) Volatile Organic Chemicals (VOCs)	
Benzene	0.001
Carbon tetrachloride	0.0005
1,2-Dichlorobenzene	0.6
1,4-Dichlorobenzene	0.005
1,1-Dichloroethane	0.005
1,2-Dichloroethane	0.0005
1,1-Dichloroethylene	0.006
Cis-1,2-Dichloroethylene	0.006
Trans-1,2-Dichloroethylene	0.01
Dichloromethane	0.005
1,2-Dichloropropane	0.005
1,3-Dichloropropene	0.0005
Ethylbenzene	0.7
Monochlorobenzene	0.07
Styrene	0.1
1,1,2,2-Tetrachloroethane	0.0001
Tetrachloroethylene	0.005
Toluene	0.15
1,2,4-Trichlorobenzene	0.07
1,1,1-Trichloroethane	0.200
1,1,2-Trichloroethane	0.005
Trichloroethylene	0.005
Trichlorofluoromethane	0.15
1,1,2-Trichloro-1,2,2-Trifluoroethane	1.2
Vinyl Chloride	0.0005
Xylenes	1.750*
(b) Non-Volatile Synthetic Organic Chemicals (SOCs)	
Alachlor	0.002
Atrazine	0.003
Bentazon	0.018
Benzo(a)pyrene	0.0002
Carbofuran	0.018
Chlordane	0.0001
2,4-D	0.07
Dalapon	0.2
Dibromochloropropane (DBCP)	0.0002
Di(2-ethylhexyl)adipate	0.4
Di(2-ethylhexyl)phthalate	0.004
Dinoseb	0.007
Diquat	0.02
Endothall	0.1
Endrin	0.002
Ethylene dibromide (EDB)	0.00005
Glyphosate	0.7

Chemical	Maximum Contaminant Level (mg/L)
Heptachlor	0.00001
Heptachlor epoxide	0.00001
Hexachlorobenzene	0.001
Hexachlorocyclopentadiene	0.05
Lindane	0.0002
Methoxychlor	0.04
Molinate	0.02
Oxamyl	0.2
Pentachlorophenol	0.001
Picloram	0.5
Polychlorinated biphenyls (PCBs)	0.0005
Simazine	0.004
Thiobencarb	0.07
Toxaphene	0.003
2,3,7,8-TCDD (Dioxin)	3×10^{-8}
2,4,5-TP (Silvex)	0.05
*MCL is for either a single isomer or the sum of the isomers. mg/L = micrograms per liter.	

Radionuclide levels should be below the maximum levels specified in Table 10-7.

Table 10-7 Maximum Contaminant Levels for Radioactivity

Constituent	Maximum Contaminant Level, pCi/l
Combined Radium-226 and Radium-228	5
Gross alpha particle activity (including Radium-226 but excluding Radon and Uranium)	15
Tritium	20,000
Strontium-90	8
Gross beta particle activity	50
Uranium	20
pCi/l = pico Curie per liter	

- Groundwater with a beneficial use of *industrial service supply* or *industrial process supply* should not contain pollutant levels that impair current or potential industrial uses.
- Groundwater with a beneficial use of *agricultural supply* should not contain concentrations of chemical constituents in amounts that adversely affect agricultural uses.

State Responsibility for CWA Section 303 - Total Maximum Daily Load Program

10.2.2.2. Overview

Section 303(d) of CWA established the total maximum daily load (TMDL) process to guide and ensure the application of state water quality standards. A TMDL represents the maximum amount or concentration of a given pollutant allowable in a given water body, based on the nature of the water body and its designated beneficial uses.

To identify water bodies in which TMDLs may be needed, SWRCB maintains a "Section 303(d) list" of water bodies in which water quality is impaired.[2] The most urgent impairments are prioritized for development of TMDL programs, which establish a means of limiting pollutant input. The goal of a TMDL program is to reduce the concentration of a specific contaminant over a specified period. Once a TMDL program has been adopted by the local RWQCB, activities within the watershed that contains the impaired water body are prohibited from increasing the concentration of the contaminant(s) addressed in the TMDL.

10.2.2.3. Impaired Water Bodies At and Near NASA Ames

South San Francisco Bay and Stevens Creek are both identified as water quality-impaired on the current 303(d) list (U.S. EPA 2005. South San Francisco Bay is listed as impaired for chlordane, DDT, diazinon, dieldrin, dioxin compounds, exotic species, furan compounds, mercury, PCBs, and selenium. Stevens Creek is impaired for diazinon. Both of these water bodies are also on the monitoring list for impairment by trash.

A water quality attainment strategy and TMDL were established in March 2004 for diazinon and pesticide-related toxicity in Bay Area urban creeks, including Stevens Creek (San Francisco Bay

San Francisco Bay RWQCB 2004. Basin Plan amendments incorporating TMDLs for mercury and PCBs in San Francisco Bay, including South San Francisco Bay, are expected to be adopted in late 2004 or early 2005. Although TMDLs have not been adopted for all the contaminants listed above, activities at ARC should avoid increasing the concentration of contaminants causing water quality impairment.

State Responsibility for CWA Section 402 - NPDES Program

10.2.2.4. Overview

CWA Section 402, enacted as an amendment to the original act in 1972, regulates discharges of pollutants from point sources to surface waters. It established the NPDES program, overseen by EPA and administered in California by the RWQCBs under the auspices of the SWRCB. Additional amendments to CWA in 1987 created a new

[2] A stream, lake, or other water body is said to be *impaired* for a pollutant if established water quality standards for that water body are not met despite implementation of technology-based controls on point sources of pollutant input.

subsection of the act (Section 402(p)) devoted to permitting for discharges of stormwater.

The NPDES program provides for two types of permits: general permits (those that cover a number of similar or related activities) and individual permits (those issued on a project-by-project basis). For example, all construction activities affecting more than 1 acre are regulated under the NPDES General Permit for Discharges of Storm Water Runoff associated with Construction Activity.

10.2.2.5. NASA Ames Stormwater Discharge Permit

Each year, ARC (including the airfield) submits a Storm Water Annual Report in accordance with its General Permit (No. CAS000001) for Discharges of Storm Water Associated with Industrial Activities. The Storm Water Annual Report includes information on monitoring observations and results, stormwater sampling results, annual inspection reporting, and the effectiveness of the Storm Water Pollution Prevention Plan (SWPPP). It also provides certification that the SWPPP is being implemented and complies with the requirements of the general permit.

The SWPPP was developed in accordance with good engineering practices to comply with federal Best Available Technology/Best Conventional Pollution Control Technology requirements and to meet the following specific objectives:

- To identify and evaluate sources of pollutants associated with industrial activities that may affect the quality of stormwater discharges and authorized non-stormwater discharges from the facility
- To identify and implement site-specific best management practices (BMPs) to reduce or eliminate pollutants associated with industrial activities in stormwater discharges and authorized non-stormwater discharges

The SWPPP is updated periodically to ensure it addresses all existing and new stormwater concerns. It undergoes formal revision approximately every 5 years

10.2.2.6. Drinking Water Standards

Title 22 of the California Code of Regulations (CCR) outlines drinking water standards in the State of California. MCLs for various contaminants are made enforceable regulatory standards under the federal Safe Drinking Water Act. MCL standards must be met by all public drinking water systems to which they apply. Primary MCLs can be found in 22 CCR Sections 64431-64444. Specific regulations for lead and copper are in 22 CCR Section 64670 et seq. Secondary MCLs that address the taste, odor, and appearance of drinking water are found in 22 CCR Section 64449.

Drinking water is also regulated pursuant to the Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65) (CCR Sections 12000–14000, California Health and Safety Code Sections 25249.5–25249.1365). Among other things, California's Safe Drinking Water and Toxic Enforcement Act prohibits companies from knowingly discharging listed chemicals into sources of drinking water. Government agencies are exempt from its requirements; it does not apply to federal activities at ARC. Nonfederal RAs and other nonfederal users at ARC are not exempt.

10.2.2.7. Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California

The state's Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California (SIP) (SWRCB 2000) established new standards for a variety of toxic pollutants. The goal of the SIP is to establish a standardized approach for permitting discharges of toxic pollutants to non-ocean surface waters in a manner that promotes statewide consistency. Accordingly, the SIP is a tool to be used in conjunction with watershed management approaches and, where appropriate, the development of TMDLs to ensure that water quality standards are met and beneficial uses are protected. It applies to discharges of toxic pollutants into California's inland surface waters, enclosed bays, and estuaries subject to regulation under the Porter-Cologne Water Quality Control Act and CWA. Such regulation may occur through the issuance of NPDES permits, the issuance or waiver of waste discharge requirements, or other regulatory approaches.

The SIP establishes implementation provisions for priority pollutant criteria established by EPA through the National Toxics Rule and the California Toxics Rule (CTR), and for priority pollutant objectives established by the RWQCBs in their respective basin plans. The CTR contains:

- Ambient aquatic life criteria for 23 priority toxics
- Ambient human health criteria for 57 priority toxics
- A provision that authorizes the state to issue schedules of compliance for **new or revised NPDES permit limits based on the federal criteria when** certain conditions are met

With certain short-term or seasonal exceptions, the state is required to use the CTR criteria together with the state's existing water quality standards when controlling pollution in inland waters and enclosed bays and estuaries.

10.2.2.8. Groundwater Management Act (AB 3030)

California's Groundwater Management Act (Water Code Sections 10750-10756) gives existing local agencies expanded authority over the management of groundwater resources in basins recognized by the Department of Water Resources. Its intent is to promote the voluntary development of groundwater management plans in order to ensure stable groundwater supplies for the future.

The act identifies the required technical components of a groundwater management plan. It also stipulates procedures for adopting a groundwater management plan, including passage of a formal resolution of intent to adopt a plan, and holding a public hearing on the proposed plan. The act also requires agencies to establish rules and regulations to implement an adopted plan, and empowers agencies to raise funds to pay for the facilities needed to manage the basin, such as extraction wells, conveyance infrastructure, recharge facilities, and testing and treatment facilities.

10.2.3. LOCAL REGULATIONS

Federal agencies are required to comply with local environmental regulations. While federal agencies are not required to conform to local land use plans, it is ARC's policy to do so to the extent feasible. The following sections describe the Santa Clara Valley Urban Runoff Pollution Prevention Program and policies and ordinances that apply specifically in Santa Clara County and the cities of Mountain View and Sunnyvale.

10.2.3.1. Santa Clara Valley Urban Runoff Pollution Prevention Program

The Santa Clara Valley Urban Runoff Pollution Prevention Program was created by an association of 13 cities and towns in the Santa Clara Valley, together with Santa Clara County and the Santa Clara Valley Water District. Its mission is to assist in the protection of beneficial uses of receiving waters by preventing pollutants generated by activities in urban service areas from entering runoff, to the extent feasible. The member agencies share a common NPDES Permit for Discharge of Storm Water to South San Francisco Bay (Santa Clara Valley Urban Runoff Pollution Prevention Program 2004). As a condition of the permit, the agencies created an Urban Runoff Management Plan, which identifies the activities various city departments are required to undertake in order to comply with the federal and state requirements of the stormwater permit. The plan includes regulatory, monitoring, and outreach measures, as well as measures designed to restore a natural flow hydrograph in urban streams.

10.2.3.2. Santa Clara County General Plan Policies

Recognizing the importance of maintaining and improving the Santa Clara County's water quality both to ensure continuing water supply and to preserve aquatic and wetland habitat, the County General Plan (County of Santa Clara 2005) includes several strategies for water quality protection, such as reducing nonpoint source pollution; restoring wetlands, riparian areas, and other habitats that improve bay water quality; and implementing watershed management planning. Specific County policies relevant to water quality include (Santa Clara County 1994):

- Adequate safeguards for water resources and habitats should be developed and enforced to avoid or minimize water pollution, including organic matter and wastes, pesticides and herbicides, effluent from municipal wastewater treatment plants, chemicals used in industrial and commercial activities and processes, industrial wastewater discharges, hazardous wastes, and nonpoint source pollution
- Multi-jurisdictional, countywide programs and regulatory efforts to address water pollution problems should have the full support and participation of each jurisdiction within Santa Clara County, including federal agencies

The County has also prepared a riparian protection ordinance that would provide for the protection and enhancement of riparian habitat along designated streams in the County.

10.2.3.3. City of Mountain View

The City of Mountain View emphasizes the need to implement BMPs to protect surface waters during all new construction. Other policies articulated in the Mountain View General Plan (City of Mountain View (draft update 2009) provide additional protection for surface and groundwater quality, including requirements to continue enforcing local, state, and federal codes that prevent groundwater contamination; coordinate cleanup of groundwater contamination through the city fire department, with assistance from other city departments and local, state, and federal agencies; establish measures to prevent pollutants from entering the city's storm drain system; and comply with the requirements and policies of the Santa Clara Valley Non-Point Source Pollution Control Program.

Since 1979, the City of Mountain View has had a Drainage and Flood Control Ordinance that was established to reduce hazards associated with development on parcels at risk for flooding. All properties in flood hazard zones must comply with this ordinance (Eckhardt and Olson 1992). Areas at ARC to which these provisions could apply[3] include portions of the Bay View area, the Eastern and Western Diked Marshes, and the Stormwater Retention Pond (see additional discussion under Flood Hazards, below).

[3] To the extent that these areas are within the City of Mountain View limits. Most of ARC is in unincorporated Santa Clara County (

10.2.3.4. City of Sunnyvale

- The Water Resources Element of the Sunnyvale General Plan includes several policies potentially relevant to surface and groundwater quality policies at ARC (City of Sunnyvale 2000). These include requirements for the city to ensure that:
- responsible parties and enforcement agencies are taking all reasonable steps to remediate known subsurface contamination
- all businesses and industrial facilities are in compliance with the city's hazardous materials storage ordinance

Additional protection for water quality is provided by the General Plan's Surface Runoff Element (City of Sunnyvale 1993), which requires the city to:

- Protect the beneficial uses of creeks and the bay
- Protect other environmentally sensitive areas
- Ensure that BMPs are implemented to reduce the discharge of pollutants in stormwater to the maximum extent practicable, and implement BMPs to minimize the total volume and rate of runoff
- Encourage residents, industrial and commercial facilities, and public agencies to report spills and illegal dumping incidents to the appropriate authorities
- Integrate surface runoff controls into new construction and redevelopment projects
- Consider the impacts of surface runoff on water quality when making land use and development decisions

In response to recent changes in NPDES permit requirements, the City of Sunnyvale adopted a Stormwater Management Ordinance (Sunnyvale Municipal Code Sec. 12.60) on August 12, 2003). New regulations established under this ordinance include:

- prohibitions of certain discharges to the stormwater drainage system
- new requirements for stormwater pollution prevention
- design criteria for stormwater treatment measures based on the area of impervious surface present at a site
- a requirement to develop site-specific stormwater management plans, including selection, implementation, and maintenance of stormwater BMPs

10.3. REGIONAL SETTING

10.3.1. CLIMATE AND PRECIPITATION

Like the rest of California's central coast, the South Bay region experiences a Mediterranean-type climate characterized by mild, wet winters and warm, dry summers. Moderated by proximity to the San Francisco Bay and the ocean, temperatures are seldom below freezing. Summer weather is dominated by sea breezes caused by differential heating between the interior valleys and the coast, while winter weather is dominated by storms from the northern Pacific Ocean that produce nearly all the annual rainfall.

Most precipitation in the region falls during the winter, when severe storms are frequent. During December, January, and February, the monthly precipitation is approximately 7 centimeters (2.7 inches), decreasing to 2.5 to 5 centimeters (1 to 2 inches) per month during the early spring. Less precipitation falls during the late spring and summer; from May through September, rainfall averages less than 1.25 centimeters (0.5 inch) per month. The average annual rainfall at ARC is approximately 35 centimeters (13.5 inches).

California experiences weather related to El Niño approximately every 3 to 7 years. An El Niño year results from changes in the distribution of heat and rainfall in the equatorial Pacific Ocean such that seawater warms and the region of thunderstorm activity moves eastward. Depending on the position of the jet stream in northern California, a strong El Niño is often associated with powerful Pacific storms and unusually wet winters in the state. El Niño storms generate high winds, producing record rainfall amounts, and can result in flooding throughout California. The most recent El Niño winter (1997-1998) was typical of this pattern, although according to Palo Alto City records, the 1997-1998 El Niño did not reach 100-year storm levels; the 30 inches that fell is typical of an 80-year storm.

10.3.2. SURFACE WATER

10.3.2.1. Surface Water Drainage

Surface waters include rivers, streams, and lakes (collectively described as inland surface waters), estuarine waters, and coastal waters. There are three major surface water bodies in the vicinity of ARC: San Francisco Bay, Stevens Creek, and the Guadalupe Slough San Francisco Bay, located approximately 1.6 kilometers (1 mile) north of ARC, is the second-largest bay on the Pacific Coast, with a surface area of approximately 1,090 square kilometers (420 square miles) at mean high water. San Francisco Bay has approximately 445 kilometers (275 miles) of shoreline exclusive of islands, and is bordered by 335 square kilometers (130 square miles) of tidal flats and marshes. It receives surface water and groundwater inflow from the entire San Francisco Basin

Surface waters of the County drain from the Santa Cruz Mountains in the west to the southern portion of the San Francisco Bay. Principal drainages of the western County are Stevens Creek, San Tomas Aquino Creek, and the Guadalupe River system.

Stevens Creek forms the western boundary of ARC and drains a watershed of 99.33 square kilometers (38.35 square miles). It is a perennial stream, although flow varies seasonally. Along with three other area streams, Stevens Creek receives stormwater discharge from the City of Mountain View storm drain system. Stevens Creek also received treated groundwater from the MEW and NASA sites. Stevens Creek discharges to San Francisco Bay.

Guadalupe Slough is located approximately 3.2 kilometers (2 miles) northeast of ARC and is fed by San Tomas Aquino Creek and the Moffett Channel. The Guadalupe Slough flows year-round, with seasonal variability.

10.3.3. GROUNDWATER

ARC is within the Santa Clara Valley groundwater basin, the largest of 31 identified groundwater basins adjoining the San Francisco Bay. The basin contains 622 square kilometers (240 square miles) of principal aquifers and has a storage capacity of 3.7 trillion liters (3 million acre-feet) in the upper 300 meters (1,000 feet) of subsurface depth. Principal areas of recharge are located.

Groundwater in the Santa Clara Valley drains north toward San Francisco Bay. The main pumping zones are the confined aquifers located at depths of 60 meters (200 feet) or more in the interior portion of the basin, together with the forebay along the elevated edges of the basin. The estimated safe perennial yield of the basin is about 120 billion liters (100,000 acre-feet) (California RWQCB 1995)

Historically, groundwater was a major supply of municipal, industrial, and agricultural water for the County. Beginning in the 1930s, however, serious overdrafts caused rapidly declining water tables, deteriorating water quality (in part as a result of salt-water intrusion), and marked ground subsidence in parts of the valley. To alleviate these problems, the Santa Clara Valley Water District constructed a series of surface reservoirs in the 1960s to promote artificial recharge of aquifers. Artificial recharge, combined with increased importation of water and control of production rates, allows the water table to rise during average or wetter-than-average years, and decline only slightly in drier-than-average years. Currently, groundwater provides about 50% of the County's total water supply, and subsidence is no longer considered a serious problem (Santa Clara Valley Water District 1989 and 2001).

10.3.4. WATER QUALITY

Geologic processes and land use activities in upstream areas of the drainage basin influence the quality of surface waters. In a natural system, surface water quality depends primarily on the mineral composition of the rocks in the upper headwater areas of the stream. Farther downstream, water quality is influenced by the mineral composition of the materials over which water flows, and by contributions from tributaries. In urban or developed streams, water quality is also affected by input from various types of point and nonpoint pollutant sources.

Point source pollution is discharged from a discrete source, such as the outfall from a pipe. Many types of pollutants can occur in point source discharges, depending on the pollutant source. By contrast, *nonpoint source pollution* is derived from widespread sources or runoff over large areas of land, and has no single location of discharge. Nonpoint source pollutants can enter waterways through urban and/or agricultural runoff, groundwater discharge, and atmospheric deposition. Typical nonpoint source pollutants include inorganic chemicals (salts, metals, and biostimulatory nutrients, such as nitrogen and phosphorus), suspended solids, pesticides, bacteria, oil and grease, and contaminants such as heavy metals that accumulate on the ground surface.

The quality of groundwater stored in aquifers reflects the geology of the basin, the quality of recharge waters, and land uses. Groundwater typically contains an elevated level of minerals or salts, depending on the type of rock or sediment that forms the aquifer. In some cases, the concentrations of minerals or salts are too high for potable uses. Land use factors that can influence groundwater quality include water withdrawals, artificial recharge, consumer waste landfills, underground chemical storage tanks, and various types of accidental chemical spills and releases. These land uses have the potential to contaminate the underground water supply, consequently preventing potable or other water use.

10.4. EXISTING SITE CONDITIONS

10.4.1. SURFACE WATER AT NASA AMES

10.4.1.1. Historic Surface Water Hydrology

ARC is located in the Stevens Creek watershed. Historically (prior to construction of ARC), surface drainage at the site flowed toward the creek and ultimately north toward San Francisco Bay. Tidal marsh historically covered a larger area, including a portion of the northern area of what is now ARC. Stevens Creek may have had a meandering channel that supported a marsh wetland corridor.

10.4.1.2. Present Surface Water Hydrology

The hydrologic network at ARC no longer flows directly to Stevens Creek and its native marshland areas. Historic surface flow pathways have been altered such that drainage channels function to control and remove stormwater runoff from developed areas, as opposed to the natural function that would allow flooding of adjacent lands. Runoff from impervious surfaces, such as paved lots and building roofs, is now collected and diverted to the Storm Water Retention Pond (SWRP) and Northern Channel at the north end of the site.

The ARC drainage area consists of about 680 hectares (1,690 acres) and is served by two drainage systems (Figure 10-1). The first system, referred to as the western drainage system, encompasses approximately 275 hectares (680 acres) and serves the NASA Research Park (NRP) area, most of the Ames Campus area, Berry Court Military Housing, and the Bay View area. It discharges directly into the SWRP. The second drainage system, referred to as the eastern drainage system, encompasses approximately 410 hectares (1,010 acres). This system serves the southeast portion of the NRP area, the Ames Campus facilities next to the runway, the Eastside/Airfield area, and the California Air National Guard (CANG) area. There is no direct connection between the eastern drainage system and the SWRP, and local flooding occurs in the northern part of the airfield during peak rainfall events due to lack of adequate drainage capacity. Storm drainpipe diameters at ARC range from 150 millimeters (6 inches) to 1,070 millimeters (42 inches). Both the western and eastern drainage systems receive input from Caltrans' U.S. Highway 101 (U.S. 101) right-of-way along the south edge of ARC.

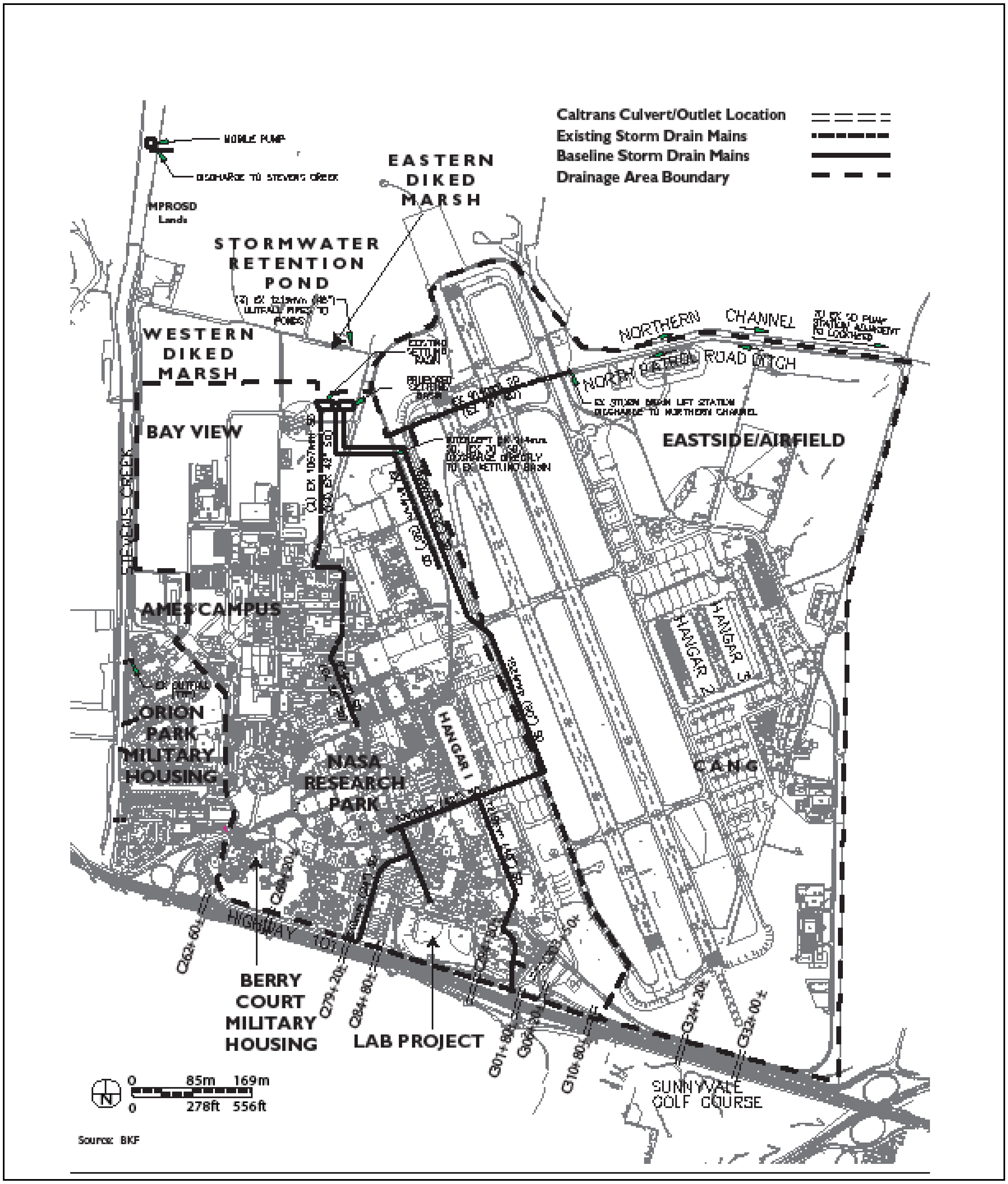

Figure 10-1 Baseline Conditions - Storm Drain System

As discussed in Chapters 12 and 13 (*Vegetation and Wetlands* and *Fish and Wildlife*), the surface drainage systems at ARC support a variety of wildlife habitats. Surface water replenishment, via stormwater, assists in maintaining the nearby wetlands and makes an important contribution to maintenance of ecological diversity in the South Bay and the San Francisco Bay Area.

The following sections describe the western and eastern drainage systems in additional detail.

Western Drainage System

The western drainage system begins in the Berry Court Military Housing and NRP area. Eight drainage structures, which serve approximately 14 hectares (35 acres) of the U.S. 101 right-of-way, discharge into the area that is drained by the western drainage system. Stormwater flows north, through Berry Court Military Housing, the NRP area, and Shenandoah Plaza, toward a main junction on the boundary between Shenandoah Plaza and the Ames Campus area, at the intersection of McCord Avenue and Bushnell Road. Stormwater from a small portion of Orion Park Military Housing flows east toward the same junction. This line passes through Orion Park Military Housing, the Main Gate area, and the ARC area.

At the McCord Avenue/Bushnell Road junction, all lines discharge into a 910-millimeter (36-inch) main trunk line. From this point, stormwater flows north through the Ames Campus area. Several other storm drain lines in the ARC area discharge directly into this main line at various points.

At the border of the ARC and Bay View areas, the 910-millimeter (36-inch) main line discharges into two 1,070-millimeter (42-inch) pipes, which flow north through the Bay View area toward a settling basin located in the northeastern portion of Bay View. From the settling basin, stormwater is discharged into the Eastern Diked Marsh, located just north of Bay View. From the Eastern Diked Marsh, flow drains to the SWRP via three 1,220-millimeter (48-inch) culverts under North Perimeter Road.

The SWRP has no outfall. During most years, water is removed by evaporation only. In some years, when wet-season flow into the SWRP exceeds the pond's storage capacity, temporary pumps are moved onto the SWRP's western levee and excess water is pumped into Stevens Creek. The capacity of the temporary pumps is less than 0.30 cubic meters per second (10 cubic feet per second), which is much less than the peak runoff of 6.2 cubic meters per second (220 cubic feet per second) from the 2-year storm for the 275-hectare (680-acre) area that discharges into the SWRP. If runoff discharges to the SWRP at a rate exceeding the pumps' capacity, water backs up, inundating the wetlands north of the Bay View area and causing localized flooding in Bay View.

Over the past 20 years, several storm drain studies have been completed, all of which agree that major renovation and rehabilitation of the western drainage system is needed (Ray Schuler, personal communication). Some intermediate measures have been taken to protect specific buildings, but significant improvements to the underground system have not been made.

Eastern Drainage System

The eastern drainage system begins in the southern portion of the Ames Campus area and the southern CANG area. Two manholes in the runway infield contain 300-millimeter (12-inch) storm drain lines that receive local runoff, as well as flow delivered to the southern airfield via two drainage structures that serve approximately 6 hectares (15 acres) of the U.S. 101 right-of-way. The storm drainpipes beneath the airfield restrict and decelerate flow somewhat when they are more than one-quarter full, but this is considered a minor concern because the full-flow velocity is only about 0.61 meters per second (2 feet per second); the more important concern appears to be the potential for trash and debris to accumulate where flow is restricted.

Stormwater from the airfield and the CANG area travels north through several storm drain lines and by overland flow. A small concrete-lined channel that flows west toward the Moffett Field storm drain lift station at the northeast corner of the airfield collects overland runoff from the golf course. This channel is commonly referred to as North Patrol Road Ditch. It is separated from the Northern Channel, which flows east, by a levee. The levee was recently raised to prevent flow in the Northern Channel (downstream of the lift station) from discharging into the smaller channel and flowing back into the lift station.

The southeastern portion of the NRP also contributes to the eastern drainage system via a main line that flows north, near the westernmost portion of the airfield. Several smaller lines from the eastern Ames Campus area enter this line along Zook Road. Just south of North Warehouse Road, the main line reaches its ultimate size of 910 millimeters (36 inches), providing a flow capacity of about 1.1 cubic meters per second (40 cubic feet per second). This is sufficient to convey runoff from an 11-hectare (26-acre) drainage area during a 25-year storm event with no surface ponding. However, the line is presently draining a much larger area and localized flooding can result if rainfall is heavy.

Stormwater from the 910-millimeter (36-inch) main, the high-speed fueling area, and the North Patrol Road Ditch, along with shallow groundwater, discharge into the lift station at B-191. The lift station consists of two 15-kilowatt (20-horsepower) pumps and has a capacity of approximately 45,000 liters per minute (12,000 gallons per minute). From the lift station, water is pumped into the Northern Channel. In addition, two portable pumps, each with a capacity of 19,000 liters per minute (5,000 gallons per minute), are located at intermediate points along North Patrol Road Ditch and discharge directly into the Northern Channel. Therefore, the total peak discharge into the Northern Channel from the site is 83,000 liters per minute (22,000 gallons per minute) or 1.40 cubic meters per second (49 cubic feet per second).

The Northern Channel flows east off of the site to follow the northern boundary of the neighboring Lockheed Martin site. It connects to the easternmost Lockheed pond, adjacent to the Moffett Channel (Sunnyvale West Side Channel), through a 1,220-millimeter (48-inch) culvert. A pump station with three pumps lifts the water into the Moffett Channel where it flows by gravity to Guadalupe Slough and then into San Francisco Bay. This pump station serves an additional 267 hectares (660 acres) of land east of ARC and has a total capacity of 117,000 liters per minute (31,000 gallons per minute) or 1.95 cubic meters per second (69 cubic feet per second).

Flood Hazards

Primarily because of past subsidence, parts of ARC are potentially subject to tidal and/or freshwater flooding during the 100-year storm and larger events. The U.S. Army Corps of Engineers estimates the 100-year tide elevation in the vicinity of ARC as 2.47 meters (8.1 feet) above mean sea level (Angeloni personal communication). The limit of 500-year tidal flooding at ARC is not significantly different from the 100-year limit because the elevation difference between the 100-year high tide and 500-year high tide is only about .08 meters (0.25 feet). Thus, the area potentially affected during a 500-year tidal-flooding event would be similar to that for the 100-year flood: the northern portion of the site. At present, however, the levees around the USFWS ponds and Stevens Creek protect the ARC site from tidal flooding. In 1980, the Bay Side levees were elevated several feet to reduce further the potential of tidal flooding, and NASA has studied an additional flood improvement project that would prevent tidal flooding during a 100-year flood. Currently the Army Corps of Engineers is conducting a study of the South Bay region in conjunction with the South Bay Salt Pond Restoration Project.

As identified above, some parts of the stormwater management system at ARC are in need of upgrades. During the El Niño storms of 1998, many basements at ARC flooded, and some buildings had as much as 0.3 to 0.6 meters (1 to 2 feet) of water on the ground floor, including Buildings N-244, N-245, N-246, N-248, and Trailer 20. Structures constructed in the floodplain area in recent years have been built on raised building pads.

10.4.1.3. Surface Water Quality

Overview

Because ARC is at the bottom of the watershed, and since the majority of the Stevens Creek watershed supports urban land uses, surface waters flowing adjacent to ARC reflect water quality typical of urban or developed streams where various types of point- and nonpoint-source pollutants affect water quality.

Because surface water drainage at ARC has been substantially modified for stormwater management, water quality concerns in this area focus on maintaining compliance with a stormwater discharge permit, as opposed to protection of drinking water, although protection of natural habitat is also addressed. Monitoring the quality of stormwater at

ARC is also important to track movement of contaminants and contaminated groundwater.

The ARC Environmental Services Office administers a quarterly storm drainage monitoring program. Low levels of organic compounds have been detected in effluent stormwater, but these are not considered significant (PAI Corporation 2004). Relatively little runoff from the western portion of ARC is discharged into the San Francisco Bay, and water quality is typically within the regulated acceptable range.

In December 1992, a 930-square meter (10,000-square foot) concrete stormwater settling basin was built northeast of the Outdoor Aerodynamics Research Facility at ARC. The purpose of the basin is to remove oil, grease, and particulate matter before runoff is discharged to the diked stormwater retention ponds south of the USFWS ponds. NASA removes sediment from the settling basin annually and tests for VOCs and metals to ensure appropriate disposal.

No recent water quality data are available for Stevens Creek. However, because the creek is downstream of urbanized areas, contaminants typical of urban runoff pollutants are likely to be present. RWQCB water quality monitoring for common urban contaminants at 12 locations on Stevens Creek was conducted during 2002 and 2003. Also, continuous (15-min interval) monitoring of temperature, pH, dissolve organics, and conductivity was conducted at four stations in 2002 and 2003.

Site-Wide Ecological Assessment

For a better understanding of the potential ecological risks associated with chemicals at ARC, the U.S. Navy conducted a Site-Wide Ecological Assessment (Ecological Assessment Report Department of the Navy Western Division Naval Facilities Engineering Command Engineering Field Activity West). As part of this effort, samples of soil, sediment, surface water, air (soil vapor), and organismal tissue were collected for chemical analyses to characterize the exposure risk to various ecological receptors. The Phase I Site-Wide Ecological Assessment provided conceptual site models, including a description of habitats, a qualitative evaluation of chemical sources and potential exposure pathways, and an overview of potential plant and animal receptors. The Phase II Site-Wide Ecological Assessment presented a quantitative and qualitative ecological risk assessment and provided information to support risk management decisions. Hydrocarbons (quantified as total petroleum hydrocarbons, diesel, motor oil, and “other heavy components”) were detected in the samples collected at drainage channels and ditches, including the Eastern Diked Marsh and the SWRP. Site 25

10.4.2. GROUNDWATER AT NASA AMES

10.4.2.1. Description of Aquifers

Several aquifers separated by less permeable clay and silt layers are present in the subsurface at ARC. They are divided into two sequences (a shallower unconfined or semi-confined sequence and a deeper confined sequence) separated by a laterally extensive clay layer. The upper aquifer sequence consists of the "A" and "B" aquifers; the lower aquifer sequence consists of the "C" and "Deep" aquifers.

"A" Aquifer

The "A" aquifer is located between the depths of 1.5 and 20 meters (5 and 65 feet) below ground surface (bgs) and is divided into two zones by a discontinuous low-permeability horizon (aquitard). The A1 aquifer zone extends from a depth of 1.5 to 9 meters (5 to 30 feet) bgs and the A2 aquifer zone[4] from 10 to 20 meters (35 to 65 feet) bgs. The "A" aquifer consists of alluvial channel deposits with the channel axes oriented approximately north-south. The degree of channel continuity has not been determined (NASA 2003).

"B" Aquifer

The "B" aquifer is located between the depths of 21 and 37 meters (70 and 120 feet) bgs and is separated from the "A" aquifer by the A/B aquitard, a locally continuous clay layer that ranges in thickness from 1.5 meters (5 feet) on the west side of ARC to 6 meters (20 feet) on the east side. The depth to the top of the A/B aquitard ranges from 15 meters (50 feet) bgs on the east side of ARC to 21 meters (70 feet) bgs on the west side. Because fewer wells penetrate the "B" aquifer, its stratigraphy is less well understood than that of the "A" aquifer. However, it is generally divided into the B2 and B3 aquifers.

"C" Aquifer

The "C" aquifer is a confined aquifer located between the depths of 47 and 76 meters (155 and 250 feet) bgs. The "C" aquifer is effectively isolated from the upper aquifers by a 6- to 12-meter (20- to 40-foot)-thick laterally continuous clay layer (the B/C aquitard), which extends from a depth of approximately 37 to 47 meters (120 to 155 feet) bgs. Few wells have penetrated the "C" aquifer, and data to characterize it are limited (NASA 2003). However, it is known to consist of relatively thin sand and gravel units interbedded with silts and clays.

[4] South of U.S. 101, the A2 aquifer is known as the B1 aquifer zone.

10.4.2.2. Groundwater Flow

Groundwater in both the "A" and "B" aquifers flows in a north-northeasterly direction toward San Francisco Bay, with a horizontal hydraulic gradient of about 0.003 to 0.007 meters per meter (0.01 to 0.02 feet per foot). The hydraulic conductivity of the "A" aquifer ranges from 2 to 73 meters per day (6 to 240 feet per day). The hydraulic conductivity of the "B" aquifer is lower, at 0.1 to 11 meters per day (0.35 to 36 feet per day) (NASA 2003). The expected long-term yield from the upper aquifers ranges between 0 and 76 liters (20 gallons) per minute.

The vertical gradient between the "A" and "B" aquifers varies due to differences in confining conditions over individual sand and gravel units, but generally ranges from 0.2 to 0.4 meters (0.50 to 1.1 feet) in the upward direction.

Groundwater in the "C" aquifer also flows north-northeasterly toward San Francisco Bay, but the horizontal hydraulic gradient is substantially less steep than in the "A" and "B" aquifers, averaging about 0.0005 meters per meter (0.001 feet per foot).

The vertical gradient between the "C" aquifer and overlying units is strongly upward, commonly exceeding 5.5 meters (18 feet).

10.4.2.3. Groundwater Use

Groundwater in the "A" and "B" aquifers (upper aquifer zones) is not currently used for domestic, municipal, or industrial water supply at ARC, with the exception of a small amount of treated groundwater that is used by the ARC Jet facility cooling towers. The northern portions of the upper aquifers are generally not considered suitable as sources of drinking water because they contain naturally high levels of dissolved solids and other inorganic content. The upper aquifers are also unattractive for use as agricultural supply because of their elevated concentrations of inorganic constituents and salinity and their limited productivity. Water from the upper aquifers may be used for industrial service and industrial process supply, although low yields present a major limitation and many uses are precluded by elevated salt concentrations. This is unlikely to change in the future, in part because other sources of supply are available for industrial uses at ARC (PRC 1994b). In addition, fresh groundwater in the upper aquifers currently serves to reduce land subsidence and inhibit the intrusion of salt water into the aquifer system, so it is important to avoid repeating the historic pattern of overuse. Water from the "A" aquifer also provides surface water replenishment that assists in maintaining wildlife habitat in nearby wetlands.

Historically, groundwater from the "C" aquifer was used for drinking and agricultural purposes at ARC. The wells associated with these uses were drilled to depths of as much as 305 meters (1,000 feet) bgs (PRC 1994b). They are no longer in use for supply. Most have been closed, but a few are still used for water quality monitoring. An additional well near Building N-267 that originally provided agricultural supply is no longer in use. Use of the "C" aquifer is currently restricted to preventing land subsidence and saltwater intrusion. Similar concerns will likely dominate both near-term and future use of water from this aquifer (NASA 2003).

10.4.2.4. Groundwater Quality and Groundwater Remediation Efforts

Since the early 1980s, numerous investigations have been conducted at and around ARC to evaluate soil and groundwater contamination in the area. Activities at the MEW Superfund site, which originates in neighboring Mountain View, the Navy, and ARC, have all contributed to an area of groundwater contamination collectively referred to as the regional plume (Figure 10-2). Additional localized contamination is a legacy of early Navy activities at what is now ARC. The following sections provide additional details on subsurface contamination as it affects groundwater, and past and current groundwater remediation efforts at ARC. A more detailed description of hazardous materials at the ARC site can be found in Chapter 17, *Hazardous Materials*.

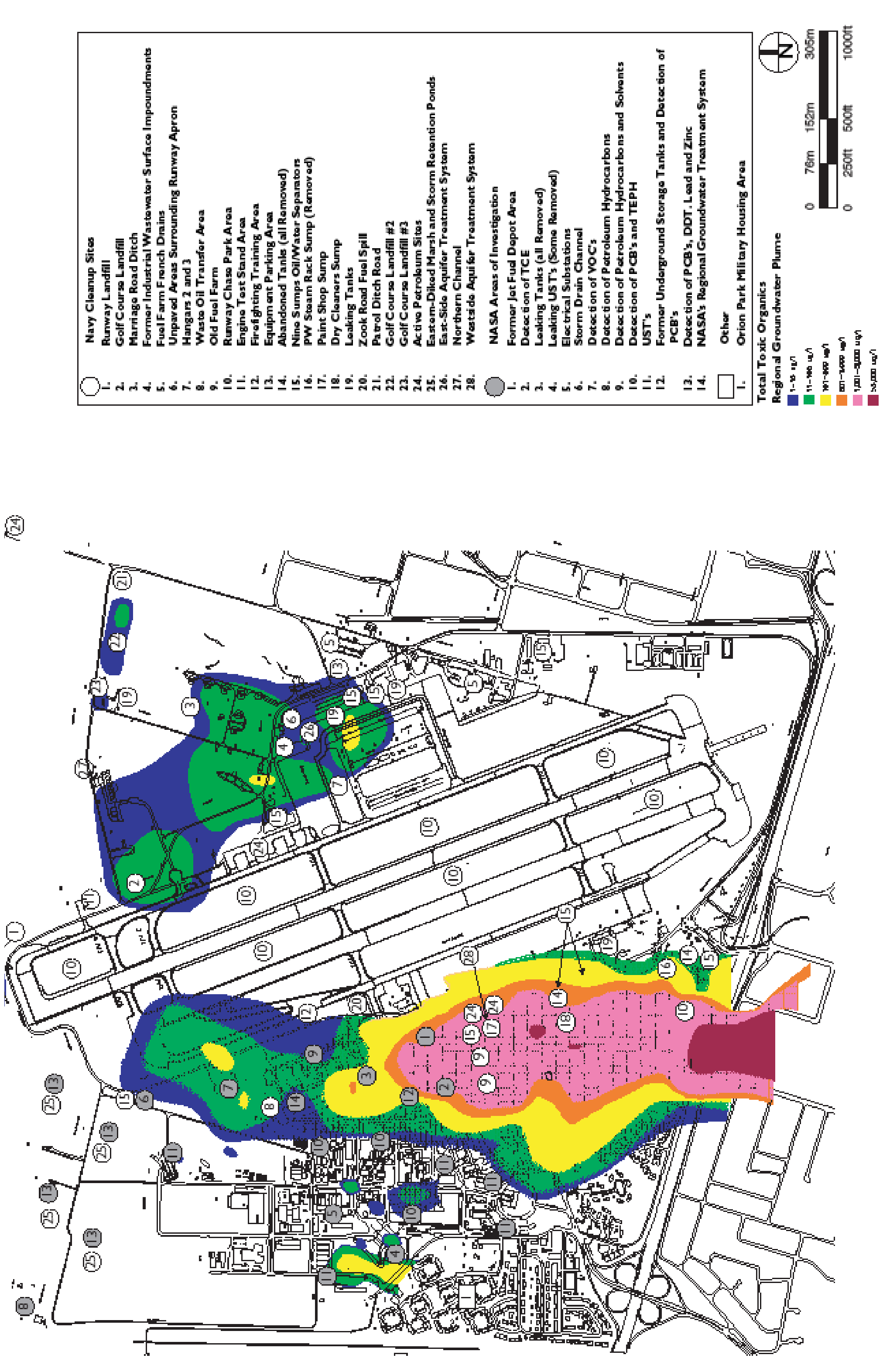

Figure 10-2 Hazardous Materials Sites and Plumes

Sources and Nature of Groundwater Contamination

The MEW Superfund site is located directly south of ARC, across U.S. 101 (Figure 10-2). The Regional Study Area assessed for contamination covers approximately 24.8 million square yards (8 square miles) bounded by El Camino Real on the south, San Francisco Bay on the north, Mathilda Avenue on the east, and Stevens Creek on the west. Approximately 20 companies own or operate facilities within a 1.5 million-square yard (0.5-square mile) Local Study Area bounded by East Middlefield Road, Ellis Street, Whisman Avenue, and U.S. 101. These "MEW companies" have been involved in the manufacturing of silicon chips, semiconductors, metal finishing operations, parts cleaning, aerospace research and development, and missile construction. Many of these industrial and high-tech activities require the use of chlorinated organic solvents, and they are believed to be the principal source of contaminants in the regional plume. Since 1981, soil and groundwater analyses have confirmed the presence of more than 70 chemicals in MEW groundwater, including trichloroethylene (TCE) and 1,1,1-trichloroethane (1,1,1-TCA). Contaminated groundwater has migrated northward from the MEW site to ARC, primarily within the A1 and A2/B1 aquifers, and to a much lesser degree in the deep "B" and "C" aquifers.[5]

Operations at ARC have used various hazardous materials, including solvents, fuels, oils, and polychlorinated biphenyls (PCBs). Previous investigations on the site indicate that some of these materials have been accidentally released into soil and/or groundwater. Approximately 60 USTs are known to have existed at ARC over the years. These tanks represent another source of groundwater contamination at ARC; chemical releases to soil and/or groundwater have been noted at many of the tank sites. All of these tanks have been removed, closed, or replaced over the past 15 years, with five replaced by new underground tanks. Three of these were removed in 2003, leaving two underground tanks on the Ames Campus (located at the Motor Pool).

Aircraft operations, repair, and maintenance activities conducted at Naval Air Station Moffett Field since it was commissioned in 1933 have also been identified as contributing to groundwater contamination (NASA 2003). Many of these activities required the use of petroleum-based fuels and chlorinated organic solvents that were stored on site in raw and waste forms. In 1987, the EPA placed the Naval Air Station at Moffett Field on the National Priority List (Superfund List) for remediation. Since that time, the Navy has identified 29 sites at Moffett Field as potential hazardous waste

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[5] *Additional information about the MEW regional plume and related remediation efforts can be obtained at information repositories established at the Superfund Records Center of the EPA's San Francisco Office (95 Hawthorne Street, Suite 403S, San Francisco, CA), and the Mountain View Public Library (585 Franklin Street, Mountain View, CA), where all technical reports and informational materials are on file and available for review.*

disposal or spill locations. These sites are in various states of investigation and remediation for cleanup by the Navy.

Groundwater Monitoring and Remediation

10.4.2.5. Overview

The MEW companies have been identified as responsible for the majority of regional plume contamination (U.S. EPA 1989; U.S. District Court 1992). In 1998 and 2000, respectively, ARC and the U.S. Navy, both identified as Potentially Responsible Parties for contamination associated with parts of the plume, negotiated Allocation and Settlement Agreements with the MEW companies, delineating the geographic portions of the plume that each party is responsible for remediating. NASA and the MEW companies signed their Allocation and Settlement Agreements. Pursuant to these agreements, the MEW companies, the Navy, and ARC are now conducting a Regional Groundwater Remediation Program. The purpose of the remediation program is to extract contaminated groundwater from the “A” and “B” aquifers and treat it to remove the contaminants.

Treated water from the combined MEW/NASA discharge line flows to Stevens Creek pursuant to NPDES permit CAS000001. Some of this treated groundwater is diverted for further treatment through ARC’s industrial waste water treatment plant and is then reused as makeup water in the and ARC Jet cooling towers and the Arc Jet boiler. Treated groundwater for the Navy’s Westside Aquifer Treatment System (WATS) located east of Hanger 1, flows through the ARC storm drain system to the settling basin, through the Eastern Diked Marsh and to the SWRP pursuant to NPDES permit CAS000001.

The Navy and MEW companies began operation of their groundwater extraction and treatment systems at the end of 1998. There are now approximately 59 “A” aquifer and 13 “B” aquifer groundwater monitoring wells owned by the MEW companies at ARC. The U.S. Navy owns and operates an additional 337 “A” aquifer, 22 “B” aquifer, and four “C” aquifer groundwater monitoring wells at the site, and is conducting remediation activities as part of its Installation Restoration Program. ARC completed the design of its own additional groundwater extraction and treatment system, which is currently operational.

10.4.2.6. NASA Ames Areas of Investigation

In 1994, 12 areas at ARC were designated as Areas of Investigation for identifying the extent of subsurface contamination. Areas of Investigation that overlie the regional plume are under EPA jurisdiction. For the Areas of Investigation under state jurisdiction, NASA entered into a Voluntary Cleanup Agreement with the California Department of Toxic Substances Control. NASA is participating in the Regional

Groundwater Remediation Plan (RGRP) to address potential sources of groundwater contamination at ARC. In 1998, the wetlands were added as Areas of Investigation 13. Although the Navy is leading the cleanup of the wetlands (Navy Operable Unit 6, Site 25), NASA contributed to the Site-Wide Ecological Assessment (discussed above), and is participating in the review of remediation options.

10.5. ENVIRONMENTAL MEASURES

The following sections describe general planning measures and specific BMPs adopted to minimize the risk of adverse effects on surface water (including stormwater) and groundwater at ARC.

10.5.1. GENERAL MEASURES TO MINIMIZE IMPACTS ON SURFACE WATER

10.5.1.1. Spill Prevention, Control, and Countermeasures Plan

The current Spill Prevention, Control, and Countermeasures Plan was prepared to identify aboveground storage of petroleum products, standard operating procedures, and detailed emergency response and mitigation actions in the event of a spill. Its specific purposes include:

- Establish procedures, methods, equipment, and other requirements to prevent the discharge of oil from non-transportation related onshore facilities into or upon navigable waters of the United States and adjoining shorelines
- Evaluate existing containment and diversionary structures constructed to control spill occurrences
- Recommend operational changes and facility modifications to minimize the probability of a spill event
- Discuss responsibilities for record keeping, inspections, personnel training, and notifications relative to plan implementation

Storm Water Pollution Prevention Program

ARC's Storm Water Pollution Prevention Program has two major objectives: (1) to identify the sources of pollutants that affect the quality of stormwater discharges and authorized non-stormwater discharges from the facility, and (2) to describe and ensure the implementation of BMPs to reduce or eliminate pollutants in stormwater discharges and authorized non-stormwater discharges. The program includes the following general BMPs. These practices apply to all industrial and maintenance activities on ARC and have been shown to be effective in preventing pollution.

- Training and supervision

- Process and equipment modification
- Raw material and product substitution or elimination
- Proper construction, demolition, and excavation activities
- Hazardous waste storage and handling
- Spill prevention and response
- Material handling and storage, including outdoor process equipment operations
- Loss prevention and good housekeeping
- Closed-loop recycling of industrial process water

As part of its Annual Report for Storm Water Discharges Associated with Industrial Activities, NASA conducts sampling and inspections to verify the effectiveness of the BMPs. Activities include:

- Stormwater sampling conducted at 12 locations on the site, including the two discharge locations, at least twice a year during the wet season (October through May)
- Visual observations conducted during the wet and dry seasons at the 12 sampling locations to identify any unusual characteristics in the stormwater discharge
- Documenting quarterly visual observations of non-stormwater discharges, if applicable
- Conducting an Annual Comprehensive Site Compliance Evaluation for all potential pollutant sources and areas of industrial activity, as identified in the SWPPP

General Measures to Minimize Impacts on Groundwater

Although any operation that involves the use of hazardous materials and/or produces hazardous waste has the potential to impact groundwater quality, most operations at ARC are unlikely to affect the quality of the groundwater or impair any of its current or potential beneficial uses, in part because of measures incorporated into ongoing operations at the site. For example, all liquid hazardous materials are stored in secondary containment in accordance with the County Hazardous Materials Storage Ordinance. (There is a more detailed description of this ordinance in Chapter 17, *Hazardous Materials).* Nonetheless, two program areas have a greater potential to result in groundwater contamination: activities that support aircraft operations, and fuel storage in underground tanks.

In 1992, approximately 9,500 liters (2,500 gallons) of jet fuel were accidentally released during the defueling of a C-130 aircraft. In 1996 and 1997, two additional accidental releases that occurred during fuel transfer activities at the Defense Fuel Supply Point resulted in a total of approximately 3,200 liters (850 gallons) of jet fuel being spilled onto exposed soils. These spills were remediated and NASA has since taken steps to reduce this type of mishap, including establishing written standard operating procedures for fuel transfer activities. However, the potential remains that similar releases may occur in the future. Accordingly, NASA has developed emergency response capabilities to mitigate future releases, minimizing the potential impact on groundwater.

10.5.1.2. ARC Best Management Practices

ARC has adopted standard BMPs that apply to all activities conducted on the site. The following standard ARC BMPs apply to the protection of surface water and groundwater.

10.5.1.3. BMPs for Construction, Demolition, and Excavation Operations

Construction, demolition, and excavation projects generate a great deal of dust, debris, waste materials, and wastewaters that, when improperly managed, can result in prohibited discharges to the storm drainage system. Various construction projects occur at ARC throughout the year. A SWPPP is required in all construction contractor specifications. Furthermore, the California Storm Water Best Management Practice Handbook for Construction Activity is made available to construction contractors working at ARC. Targeted constituents are sediment, heavy metals, toxic materials, floatable materials, oil and grease, petroleum products, and contaminated groundwater.

The following BMP is applicable to all construction, demolition, and excavation activities at ARC that could potentially release pollutants to the storm water. Requirements of this BMP are:

- Each job site should be managed in such a manner to avoid discharges of prohibited substances to the storm drain system
- Routine inspection of job site should be performed to ensure that construction, demolition, and excavation materials (liquid or solid) are not entering the storm drain system
- Keep the job site tidy and clean up debris regularly
- Placement of cleaning equipment or tools over catch basins is prohibited
- Storm drain catch basins should be covered to prevent pollutants and sediments from entering the storm drain system

Special precautions should be employed if rain is forecasted or if water is applied. These precautions should include, but are not limited to:

- Increased monitoring frequency for storm drains and rectifying ongoing releases or identifying and preventing any possible release
- Reduction in activities that cause material to encounter rainwater
- Following all construction, demolition, and excavation activities; the job site should be swept to remove debris and residue. Catch basins should be vacuumed or cleaned to remove sediment and debris
- Construction, demolition, and excavation materials (gravel, sand, lumber, cement, chemicals, contaminated equipment, etc.) should be stored under a roof or structure or covered with a tarp or plastic visqueen. Covered items should be secured with ropes, sandbags, or bricks to prevent or minimize contact with rainwater. For large piles of soil or other construction materials where tarps or other covers are not feasible, placement of filtering media (for example, straw bales, rocks, and silt fences) around the base of each pile or at the storm drain inlet is required to remove these materials from rainwater runoff. Do not store items near catch basins
- Wet concrete and concrete cutting waters should be conducted to prevent discharge to the storm drains. Blocking or plugging drains in the vicinity may be warranted. This can be done in a number of ways, such as placing weighted plastic visqueen over drains or using sandbags or spill control PIGS
- Residual concrete and concrete/asphalt cutting effluent from equipment and machinery should not be discharged to the storm drain. Estimate the amount of wastewater that will be generated and arrange to have a storage container (tank) available. Properly dispose of wastewater off site
- Outdoor concrete work should be postponed if rain is forecasted unless precautions are taken to prevent discharge of wet concrete and other construction debris to the storm drain
- During paint scraping operations, use impermeable ground cloths, such as plastic sheeting, to collect dust, and paint chips
- Use impermeable ground cloths while painting. Place in-use paint buckets in a pan or over plastic sheeting to ensure that accidental spills are not discharged to the storm drain
- Mixing of paint should take place indoors or in a place that is not exposed rain or wind
- At the end of the workday, store paint buckets and other equipment away from contact with stormwater in a secured, secondarily contained area

- Treat a paint spill as a chemical spill. Capture the material before it flows to the storm drain. Clean it up promptly. Report the event to NASA Environmental Services Office, Code QE, at 650/604-5602, or call 911 for large spills
- Outdoor sandblasting should comply with the following:
- Tarpaulins or ground cloths should be placed beneath the work area to capture the blasting medium and particles from the surface being cleaned
- Consider curtailing sandblasting on a windy day or, if rain is forecast, to minimize the amount of area that will require clean up and to avoid sand waste from being washed into the storm drain
- Vacuum the work area when job is complete
- If sandblasting paint containing lead, cadmium, or other toxic contaminants, comply with the following:
- Obtain approval from the NASA Environmental Services Office and the Occupational Safely, Health, and Medical Services Office at 650/604-5602
- Follow measures outlined in “Outdoor Sandblasting” listed above
- Perform air monitoring is required
- Follow OSHA regulations for worker safety
- For broken lines that contain substances other than potable water, the operator shall immediately notify the NASA Environmental Services Office and initiate the following actions immediately:
- Berm the area to prevent runoff to the storm drain
- Immediately block off adjacent storm drain catch basins

Good Housekeeping BMPs

Good housekeeping BMPs are designed to maintain a clean and orderly work environment. Often the most effective first step toward preventing pollution in stormwater from industrial sites simply involves using good common sense to improve the facility’s basic housekeeping methods. Poor housekeeping can result in more waste being generated than necessary and an increased potential for stormwater contamination. A clean and orderly work area reduces the possibility of accidental spills caused by mishandling of chemicals and equipment, thereby reducing safety hazards. Well-maintained material and chemical storage areas should minimize discharges of materials/pollutants that could contaminate stormwater. Simple procedures can be used to promote good housekeeping, including improved operation and maintenance of industrial machinery and processes, material storage practices, material inventory controls, routine and regular clean-up schedules, maintaining well organized work areas, and educational programs.

ARC's policy is that managers, including line supervisors, are responsible for ensuring that personnel are educated in proper environmental hazards management, including stormwater pollution prevention. This BMP is applicable to all industrial activities at ARC.

Targeted constituents of the BMP are sediments, nutrients, floatable materials, oxygen-demanding substances, heavy metals, toxic materials, and oil and grease.

Requirements of the Good Housekeeping BMP are as follows:

- Conduct formal monthly inspections of all buildings and surrounding areas to ensure the following:
- Outside areas are cleaned and organized
- Drips, leaks, or evidence of such, from equipment or pipes are contained
- Adequate space exists in work areas to minimize spill potential
- Garbage is removed regularly
- Walkways and passageways are easily accessible
- Walkways and passageways are free of materials that could be spilled
- Evidence is noted of dust from painting, sanding, or other industrial activities
- Cleanup procedures for spilled materials exist

An inspection log should be maintained in order to feed other environmental reporting requirements at ARC. Moreover, a formal annual inspection of ARC is conducted by the Environmental Office to verify industrial activities in the SWPPP and identify new activities and BMPs.

- Conduct an annual inventory of chemical substances, including hazardous materials and pollutants present on site. This inventory shall meet the requirements of the Santa Clara County Hazardous Materials Storage Ordinance inventory of chemicals and toxic substances
- Maintain a current file of all Material Safety Data Sheet (MSDS) for chemicals and toxic substances
- Label chemical containers in accordance with OSHA, EPA, Department of Transportation, and other applicable federal, state, and local requirements

- Maintain dry and clean floors and ground surfaces by using brooms, shovels, vacuum cleaners, and cleaning machines
- Regularly pickup and dispose of garbage, debris, and waste material
- Make sure equipment is working properly
- Routinely inspect for leaks or conditions that could lead to discharges of chemicals or contact of stormwater with raw materials, intermediate materials, waste materials, or products
- Ensure that all employees understand spill cleanup procedures.
- Improper storage can result in the release of materials and chemicals that can cause stormwater runoff pollution. Proper storage techniques include:
    - Providing adequate aisle space to facilitate material transfer and easy access for inspections
    - Storing containers, drums, and bags away from direct traffic routes to prevent accidental improper weight distribution of containers
    - Stacking containers according to manufacturer's instructions to avoid damaging the containers from improper weight distribution
    - Storing containers on pallets or similar devices to prevent container corrosion, which can result from moisture on the ground

- Maintain an up-to-date inventory of all materials (hazardous and non-hazardous). This inventory will reduce additional material costs caused by overstocking. Inventorying also enables the tracking of materials stored and handled on site and identifies which materials and activities pose the most risk to the environment
- During inventory of hazardous materials, clearly mark those that require special handling, storage, use, and disposal considerations
- Keep the work site clean and orderly. Remove debris in a timely fashion. Sweep the area
- Cover materials of particular concern, such as hazardous materials or sand piles that must remain outdoors, particularly during the rainy, season
- Educate employees who are doing the work
- Inform onsite contractors of ARC policy. Include appropriate provisions in their contract to ensure proper housekeeping and disposal practices are implemented

- Make sure that nearby storm drains are well marked to minimize the chance of inadvertent disposal of residual paints and other liquids
- Do not dump waste liquids down the storm drain
- Advise concrete truck drivers to not wash their truck over the storm drain
- Placement of cleaning equipment or tools over catch basins is prohibited

10.5.1.4. BMP for Material Handling and Storage

This BMP includes all procedures to minimize the potential for spills and leaks and to minimize exposure of significant materials to stormwater and authorized non-stormwater discharges. Accidental releases of materials from underground liquid storage tanks, aboveground storage tanks, drums, containers, and dumpsters present the potential for contaminated stormwaters with many different pollutants. Materials spilled, leaked, or released from storage containers and dumpsters may accumulate in soils or on the surfaces where they may be transported by stormwater runoff. Currently, hazardous materials are stored outdoors at ARC in secondarily contained and roofed chemical storage facilities or lockers. Standard Operating Procedures prohibit materials from contacting stormwater runoff in the event of an accident or spill.

This BMP also addresses the loading and unloading of materials, which usually takes place outside at the NASA Ames Supply Support Facility at N-255, and the California Air National Guard Facilities 681 and 682. Loading or unloading of materials occurs in two ways: materials in containers or direct liquid transfer. Materials leaked, spilled, or lost during loading/unloading may collect in the soil or on other surfaces and be carried away by runoff or when the area is cleaned. Rainfall may wash pollutants from machinery used to unload or move materials. The loading or unloading may involve rail or truck transfer.

Targeted constituents of this BMP include floatable materials, oxygen demanding substances, heavy metals, toxic materials, and oil and grease.

This BMP is applicable to all industrial activities at ARC, in particular those areas where containers storing liquid materials are located outside of buildings. It should be noted that the storage of reactive, ignitable, or flammable liquids must comply with the California Health and Safety Code, the Santa Clara County Hazardous Materials Storage Ordinance, and the local fire code.

Requirements of the Material Handling and Storage BMP are as follows:

- Prevent or reduce the discharge of pollutants to stormwater from outdoor container storage areas by storing hazardous substances in chemical storage lockers or facilities, installing safeguards against accidental releases, providing secondary containment, conducting weekly inspections of hazardous waste, monthly inspections of hazardous materials, and training employees in standard operating procedures and small spill cleanup techniques
- Protect materials from rainfall, runoff, and wind dispersal by implementing controls such as:
- Store materials indoors or in a chemical storage locker
- Cover the storage area with a roof
- Minimize storm water run-on by enclosing the area or providing a berm
- Storage of oil and hazardous materials must meet specific federal, state, and local standards, including:
- A Spill Prevention Control and Countermeasure Plan
- Secondary containment, integrity, and leak detection monitoring
- Emergency preparedness plans
- Operator must be trained in proper storage
- All hazardous materials storage areas must be inspected monthly; hazardous waste accumulation areas must be inspected weekly. Hazardous materials and hazardous waste inspections must be documented. Documentation must be kept on file for a period of five years. Inspections must include the following questions:
- Are all materials correctly segregated?
- Are hazardous materials/waste storage areas clearly identified, describing hazard class(es) of materials in storage?
- Are all containers (and secondary containment, if needed) labeled to identify the material/waste hazard?
- Is the secondary containment free of liquid or debris?
- Are all containers in good condition?
- Are MSDSs available for all hazardous materials in inventory?
- Hazardous materials shall be properly stored:
- Hazardous materials should be placed in a designated area
- The designated storage area should be covered with a roof

- Designated areas should be paved, free of cracks and gaps, and liquid tight in order to contain leaks and spills
- Liquid materials should be secondarily contained to hold 10% of the volume of all the containers or 110% of the volume of the largest container, whichever is greater
- Drums stored in an area where unauthorized persons may gain access must be secured to prevent accidental spillage, pilferage, or any unauthorized use
- Employees trained in emergency spill cleanup procedures should be present where dangerous waste, liquid chemicals, or other wastes are loaded or unloaded

Using engineering safe guards and thus reducing accidental releases of pollutants can prevent operator errors. Safeguards include:

- Overflow protection devices on tank systems to warn the operator to automatically shutdown transfer pumps when the tank reaches full capacity
- Protective guards (bollards) around tanks and aboveground piping to prevent vehicle or forklift damage
- Clearly tagging or labeling all valves to reduce human error

Weekly inspections of tanks should be conducted to include:

- A check for external corrosion and structural failure
- A check for spills and overfills due to operator error
- A check for failure of piping system (pipes, pumps, flanges, coupling, hoses, and valves)
- A check for leaks or spills during pumping of liquids or gases from truck or railcar to a storage facility or vice versa
- Visual inspection of new tank or container installation, loose fittings, loose valves, poor welding, and improper or poorly fitted gaskets
- Inspection of tank foundations, connections, coatings, tank walls, and exposed piping system. Look for corrosion, leaks, cracks, scratches, and other physical damage that may weaken the tank or container system

Proper use of pesticides and fertilizers will reduce the risk of loss to storm water. In addition:

- Pesticide applicators must be licensed with the California Department of Pesticide Regulation and county agricultural commissioners

- No person shall pollute water supplies or waterways while loading, mixing, or applying pesticides on ARC property
- No person shall transport, handle, store, load, apply, or dispose of any pesticide, container, or apparatus in such a manner as to pollute water supplies or waterways, or cause damage or injury to land, humans, plants, or animals
- Pesticides/fertilizers should not be applied during the wet season as they may be carried from the site by the next storm
- Avoid over-watering not only to conserve water but to avoid the discharge of water that may have become contaminated with nutrients and pesticides
- Store pesticides and application equipment in a responsible manner
- Properly dispose of the used containers

Stormwater from parking lots may contain undesirable concentrations of oil, grease, suspended particulates, and metals such as copper, lead, cadmium, and zinc, as well as the petroleum byproducts of engine combustion. Deposition of air particulates, generated by the facility or by adjacent industries, may contribute significant amounts of pollutants. Therefore, the following maintenance operations shall occur:

- Sweeping of main streets shall be conducted monthly and sweeping of parking lots shall be conducted quarterly. Sweeping should be conducted with a vacuum sweeper, rather than a mechanical brush sweeping device, which is not as effective at removing the fine particulates
- Cleaning of catch basins and building laterals shall be conducted annually. Maintain painted stencils that mark storm drain inlets "No Dumping! Flows to Bay." This stencil will minimize inadvertent dumping of liquid wastes;
- Debris shall be disposed of off center at an approved landfill site

Prevent or reduce the discharge of pollutants to stormwater from outdoor loading/unloading of materials through implementation of the following:

- When materials are received, they shall remain in the travel path only for a time reasonably necessary to transport the materials but no longer than 24 hours
- Use a written operations plan that describes procedures for loading and/or unloading
- Have an emergency spill cleanup plan readily available
- Employees trained in spill containment and cleanup should be present during the loading/unloading

- Establish depots of cleanup materials next to or near each loading/unloading area and train employees in their use
- Park delivery vehicles so that spills or leaks can be contained
- Cover the loading/unloading docks to reduce exposure of materials to rain

10.5.1.5. BMPs for Outdoor Process Equipment Operations and Maintenance

Outdoor equipment includes rooftop cooling towers or air conditioners, rooftop air vents for industrial equipment, outdoor air compressors, and other service equipment. Indoor wet processes include areas where leaks or discharges may discharge to outdoor areas, and material transfer areas, such as loading areas, where forklifts or trucks may carry pollutants outdoors on their tires Ordinary precautions, such as those below, may suffice for smaller equipment.

Targeted constituents of this BMP include oil and grease, heavy metals, and antifreeze.

This BMP is applicable to all areas with outside process equipment at ARC. Requirements are as follows:

- Inspect equipment on a regular basis for leaks malfunctions, staining on and around the equipment, and other evidence of leaks and discharges
- Assign the inspector the responsibility of reporting a spill
- Develop a routine for taking actions on reporting, cleaning up the spill, and repairing the leak to prevent future spills
- If absorbent material is used on a spill, sweep and dispose of material in a timely manner
- Place equipment on an impermeable surface or install a drip pan beneath potential leak points
- Construct a simple roof to minimize the amount of rainwater that contacts the equipment and install a berm to prevent runon and runoff
- Air compressors and other equipment produce small quantities of automatic blowdown water, which commonly contains lubricating oil or other potential pollutants. Blowdown water may not be discharged to any impermeable outside areas or to the storm drain system. Blowdown water must be discharged to the sanitary sewer or to a permeable area (for example, landscaping area)
- Electrical equipment should be managed to:
- Take care in tapping oil-containing equipment. Avoid drips and leaks whenever possible

- Place an absorbent pad with the impervious lining side down under electrical equipment prior to tapping. The absorbent material will retain small drips with impervious backing in limiting leakage
- Properly dispose of oil-contaminated materials. Any PCB-contaminated absorbent materials must be bagged, labeled, and disposed of in accordance with 40 CFR 761
- For all PCB-containing electrical equipment, follow NASA Ames Procedures for PCB Management. If you have any questions regarding the PCB Program, call the NASA Environmental Services Office at 650/604-5602

10.5.1.6. BMPs for Spill Response and Prevention

This BMP includes spill cleanup procedures and necessary cleanup equipment based upon the quantities and locations of significant materials that may spill or leak. Spills and leaks together are one of the largest industrial sources of stormwater pollutants, and in most cases are avoidable. The most common causes of unintentional releases and spills include:

- Lack of awareness regarding proper hazardous materials handling procedures
- External corrosion and structural failure of storage containers
- Improper equipment or facility installation
- Spills and overfills due to operator error
- Failure of piping systems (pipes, pumps, couplings, hoses, and valves)
- Leaks during pumping of liquids or gases from trucks to a storage facility and vice-versa

Establishing standard operating procedures, such as safety and spill prevention procedures, along with proper employee training can reduce these accidental releases. Avoiding spills and leaks is preferable to cleaning them up after they occur, not only from an environmental standpoint, but also because spills cause increased operating costs and lower productivity.

Targeted constituents of this BMP include floatable materials, heavy metals, toxic materials, and oil and grease.

This BMP is applicable to all industrial activities at ARC. Requirements for implementation are as follows:

- Hazardous materials are segregated according to hazard class, stored in secondary containment to prevent accidental release, labeled according to the container's contents and the material's hazard, and accurately inventoried for reporting to the NASA Environmental Services Office, and to federal, state, and local regulatory agencies
- Hazardous materials storage areas are equipped with emergency spill response equipment appropriate to the types of materials in use and storage
- The hazardous materials storage areas are inspected monthly to ensure storage requirements are being satisfied
- It is the responsibility of managers and supervisors at ARC to ensure employee training in these areas:
- Safe handling of hazardous materials in the employee's work place, including spill response, segregation, and secondary containment
- Proper disposal of hazardous waste, including sewer discharge prohibitions, pickup procedures, and Emergency Response and First Responder Training

Building Emergency Action Plans are available at each building and include a Hazardous Substance Plan. The Hazardous Substance Plan details the chemical inventory of the building, hazardous substance spill procedure, and hazardous chemicals training.

- The NASA Ames Site Contingency Plan is the guideline for emergency response to incidents involving hazardous waste and/or hazardous waste constituents. The emergency coordination and notification for incidents involving hazardous waste shall be in accordance with federal, state, and local statutory and regulatory requirements. Contact the NASA Environmental Services Office at 650/604-5602 for additional information.
- In the event of a spill near a storm drain: block, dike, divert, and/or cover the storm drain to prevent a release from entering the stormwater system.
- In the event of a spill that cannot be cleaned up by two people within 0.5 hour with cleanup materials available on the scene, call Ames Dispatch at 911 or 650/604-5555 immediately.

10.5.1.7. Waste Handling and Recycling BMP

This BMP includes the procedures or processes to handle, store, or dispose of waste materials or recyclable materials. Hazardous waste is accumulated at NASA Ames Facility N-265, and NRP Building 950. The containment structure at the accumulation areas prohibits materials from contacting stormwater runoff. Rainwater captured within the containment structures is pumped to portable holding tanks and the water is determined to be hazardous or non-hazardous. The water is either discharged to the sanitary sewer system or managed as a hazardous waste, as determined from the characterization.

Targeted constituents of this BMP include heavy metals, toxic materials, floatable materials, oxygen demanding substances, and oil and grease.

This BMP is applicable to all industrial activities at ARC and requires the following measures.

- Prevent or reduce the discharge of pollutants to stormwater from outdoor container storage areas by storing hazardous waste in chemical storage lockers or facilities, installing safeguards against accidental releases, providing secondary containment, conducting weekly inspections, and training employees in standard operating procedures and small spill cleanup techniques
- Protect materials from rainfall, runoff, and wind dispersal by implementing controls such as:
    - Store materials indoors or in a chemical storage locker;
    - Cover the storage area with a roof; and
    - Minimize stormwater runon by enclosing the area or providing a berm.
- Storage of waste oil and hazardous materials must meet specific federal, state, and local standards, including:
    - A Spill Prevention Control and Countermeasure Plan
    - Secondary containment, integrity, and leak-detection monitoring
    - Emergency preparedness plans

Waste materials and recyclables are segregated according to hazard class, stored in secondary containment to prevent accidental release, labeled according to the container's contents and the material's hazard, and accurately inventoried for reporting to the NASA Environmental Services Office and to federal, state, and local regulatory agencies

- Waste materials and recyclables storage areas are equipped with emergency spill response equipment appropriate to the types of materials
- The waste materials and storage areas are inspected weekly to ensure that storage requirements are being satisfied. Hazardous waste inspections must be documented. Documentation must be kept on file for a period of five years. Inspections must include the following questions:
    - Are all materials correctly segregated?

- Are hazardous waste storage areas clearly identified, describing hazard class(es) of materials in storage?
- Are all containers (and secondary containment, if needed) labeled to identify the waste material and hazard class?
- Are all containers intact and in good condition?

It is the responsibility of managers and supervisors at ARC to ensure employee training in these areas:

- Safe handling of hazardous wastes in the employee's work place, including spill response, segregation, and secondary containment
- Proper disposal of hazardous waste, including sewer discharge prohibitions and pickup procedures
- Emergency Response and First Responder training

Building Emergency Action Plans are available at each building and include a Hazardous Substance Plan. The Hazardous Substance Plan details the chemical inventory of the building, hazardous substance spill procedure, and hazardous chemicals training.

The NASA-Ames Research Center Site Contingency Plan is the guideline for emergency response to incidents involving hazardous waste and/or hazardous waste constituents. The emergency coordination and notification for incidents involving hazardous waste shall be in accordance with federal, state, and local statutory and regulatory requirements. Contact the NASA Environmental Services Office, Code QE, at 605/604-5602.

10.5.2. MITIGATION MEASURES

The NASA Ames Development Plan (NADP) Final Programmatic Environmental Impact Statement (FEIS) identified mitigation measures to address potential hydrology and water quality impacts from build out of Mitigated Alternative 5 in the NADP (Design, Community & Environment 2002). For a full discussion of impacts and mitigation measures related to the NADP, see the FEIS.

Chapter 11. Prime and Unique Farmlands

11.1. OVERVIEW

This section discusses the regulatory framework relevant to farmland protection in the vicinity of Ames Research Center.

The Farmland Protection Policy Act of 1984 (FPPA) encourages federal agencies to minimize unnecessary and irreversible conversion of prime and unique farmlands to non-agricultural use. Prime farmland is defined as land that has the best combination of physical and chemical characteristics for producing food, feed, fiber, forage, oilseed, and other agricultural crops with minimum inputs of fuel, fertilizer, pesticides, and labor, and without intolerable soil erosion. Unique farmland is land other than prime farmland that is used for the production of specific high-value food and fiber crops such as, citrus, tree nuts, olives, cranberries, fruits, and vegetables.

11.2. REGULATORY REQUIREMENTS

11.2.1. FARMLAND PROTECTION POLICY ACT

The FPPA requires federal agencies to consider how farmland may be affected by their activities or responsibilities that involve 1) financing or assisting construction of improvement projects or 2) acquiring, managing, or disposing of federal land and facilities. To comply with the provisions of the FPPA, the lead federal agency must consult with the Natural Resources Conservation Service (NRCS) and complete a Land Evaluation and Site Assessment (LESA) for each affected site or area. The federal lead agency is responsible for coordinating completion of the Farmland Conversion Impact Rating Form (Form AD-1006) with the NRCS.

11.2.2. FARMLAND MAPPING AND MONITORING PROGRAM

The state’s Farmland Mapping and Monitoring Program (FMMP), part of the Division of Land Conservation, California Department of Conservation (DOC), is responsible for mapping and monitoring important farmlands for most of the state’s agricultural areas. These maps are updated every two years based on information that FMMP receives from local agencies. The important farmland mapping system defines four categories of farmlands based on various characteristics including physical and chemical features, current use, and irrigation water supplies. These categories are prime farmland, farmland of statewide importance, unique farmland, and farmland of local importance.

11.2.3. Santa Clara County General Plan

Generally, it is the policy of Santa Clara County to preserve agricultural lands and open space (Policy R-LU-35, County of Santa Clara General Plan 2005).

11.3. REGIONAL SETTING

Prior to World War II, the fertile valley of Santa Clara County consisted mostly of vast orchards of plums, apricots, and other fruits. In the decades following World War II, however, these orchards were quickly replaced with urban development to support an expanding high technology industry. Hence, this former valley of farmland was transformed into a "Silicon Valley."

Historically at ARC, agricultural crops were cultivated within two general areas. These are designated Sites "A" and "B."

- Site "A," which has 56.59 hectares (139.83 acres), was obtained by ARC in 1968 and leased to private individuals for farming until 1988. Agricultural use has ceased since that time and no longer occurs in the area. Several facilities and access roads were previously constructed in this area, including the Outdoor Aerodynamic Research Facility (OARF) and the Telecommunications Gateway Facility (both constructed in 1976). In addition, a storm water/oil separation basin was built in 1992.
- Site "B," which has 46.8 hectares (115.6 acres), was leased by the U.S. Navy to private individuals until 1992. Much of this land is within the airfield runway clear zone. In the early 1990s, agricultural use was discontinued south of the runway to eliminate the strike hazard to aircraft from birds attracted to the crops (NASA 2003).

11.4. EXISTING CONDITIONS

Five soil types present at ARC (see Chapter 9, Geology, Seismicity, and Soils) are classified as prime and unique farmland soils by the NRCS. Current mapping available through FMMP indicates that there are currently no prime or unique farmlands located at ARC. No additional information was available through FMMP regarding the classification conversion.

11.5. ENVIRONMENTAL MEASURES

There are currently no prime or unique farmlands located at ARC; therefore, there is no need for related environmental measures related to the preservation and/or operation of farmlands or agricultural lands at ARC.

Chapter 12. Vegetation and Wetlands

12.1. OVERVIEW

This section provides information about biological resources at ARC, including the types and distribution of habitat, vegetation, and special-status plant species. Applicable regulations pertaining to protected vegetation and wetlands are discussed, as well as existing measures and programs that ARC has implemented to protect vegetation and wetlands. The information presented in this section was drawn from the results of biological studies that have been previously conducted at the ARC. The information presented in this chapter was drawn from the NASA Ames Development Plan Final Programmatic Environmental Impact Statement (Design, Community & Environment 2002) and from the Storm Water Retention Pond/Title Feasibility Study (2005).

12.2. REGULATORY REQUIREMENTS

This section describes federal and state laws relevant to biological resources.

12.2.1. FEDERAL LAWS

The federal laws that regulate the treatment of plant and wetland resources are the Endangered Species Act of 1973, as amended (ESA); the Clean Water Act (CWA); and the National Environmental Policy Act of 1969 (NEPA). The following section discusses the relevant portions of each act.

12.2.2. ENDANGERED SPECIES ACT

The federal ESA protects plant and wildlife species that are listed as threatened or endangered, and their habitats. "Endangered" species, subspecies, or distinct population segments are those that are in danger of extinction through all or a significant portion of their range, and "threatened" species, subspecies, or distinct population segments are likely to become endangered in the near future. The U.S. Fish and Wildlife Service (USFWS) administers the ESA.

12.2.2.1. Section 7

Section 7 of the ESA requires federal agencies to ensure that their actions do not jeopardize the continued existence of a listed fish or wildlife species, or destroy or adversely modify that species' critical habitat; as defined and designated by federal regulations. Under Section 7 of the ESA, federal agencies are also prohibited from jeopardizing the continued existence of any federally listed plant species in issuing any permit.

12.2.2.2. Section 9

Section 9 of the ESA prohibits removing, digging up, cutting, maliciously damaging, or destroying federally listed plants on sites under federal jurisdiction.

12.2.3. CLEAN WATER ACT

The CWA is an amendment to the Federal Water Pollution Control Act of 1972, which outlined the basic structure for regulating discharges of pollutants to waters of the United States. Several sections of this act pertain to regulating impacts to wetlands. Section 401 (Water Quality Certification) specifies requirements for permit review, particularly at the state level. The discharge of dredged or fill material into waters of the United States is subject to permitting under Section 404 (Discharge of Dredged and Fill Materials into Waters of the United States). The U.S. Army Corps of Engineers (Corps) and the Environmental Protection Agency (EPA) administer the Clean Water Act.

12.2.3.1. Section 401: Water Quality Certification

Section 401 of the federal Clean Water Act gives individual states the authority to issue, waive, or deny certification that a proposed activity is in conformance with state water quality standards. The state's Regional Water Quality Control Boards review projects, including those that require permits from the Corps under CWA Section 404. The ARC site is under the jurisdiction of the San Francisco Bay Regional Water Quality Control Board.

12.2.3.2. Section 404: Discharge of Dredged and Fill Materials into Waters of the United States

The Corps and EPA regulate the placement of fill and dredged materials into waters of the United States under CWA Section 404. Waters of the United States include lakes, rivers, streams, and their tributaries, as well as wetlands. Wetlands are defined for regulatory purposes as areas "inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." Project proponents must obtain a permit from the Corps for all discharges of dredged or fill material into waters of the United States, including wetlands, before proceeding with a proposed action.

The Corps may either issue individual permits on a case-by-case basis or general permits at a program level. General permits are pre-authorized, and are issued to cover similar activities that are expected to cause only minimal adverse environmental effects. Nationwide permits are a type of general permit issued to cover particular fill activities. Nationwide permits have a set of conditions that must be met for the permits to apply to a particular project, as well as specific conditions that apply to each nationwide permit.

12.2.4. NATIONAL ENVIRONMENTAL POLICY ACT

NEPA requires federal agencies to include in their decision-making process appropriate and careful consideration of all environmental effects of a proposed action and of possible alternative actions. Measures to avoid or minimize the adverse effects of proposed actions and to restore and enhance environmental quality as much as possible must be developed and discussed where feasible.

12.2.4.1. Federal Executive Orders 11988 and 11990

Executive Order 11988 (Floodplain Management) and Executive Order 11990 (Protection of Wetlands) address floodplain and wetland issues related to public safety, conservation, and economics. It generally requires federal agencies constructing, permitting, or funding a project to:

- Avoid incompatible floodplain and wetland development
- Be consistent with the standards and criteria of the NFIP
- Restore and preserve natural and beneficial floodplain and wetland values

12.2.5. STATE LAWS

The most relevant state laws regulating biological resources are the California Endangered Species Act (CESA) and the California Native Plant Protection Act (CNPPA).

12.2.5.1. California Endangered Species Act

The CESA, which is administered by the California Department of Fish and Game (CDFG), protects wildlife and plants listed as threatened and endangered by the California Fish and Game Commission. CESA requires state agencies to conserve threatened and endangered species (Section 2055), and therefore restricts all persons from taking listed species except under certain circumstances. The CESA defines “take” as any action or attempt to “hunt, pursue, catch, capture, or kill.” CDFG may authorize take under Section 2081 agreements, except for designated “fully protected species.” The requirements for an application for an incidental take permit under CESA are described in Section 2081 of the California Fish and Game Code and in final adopted regulations for implementing Sections 2080 and 2081.

While CESA does not apply directly to federal agencies, ARC does consider the impacts on state listed species during NEPA analyses. CESA does apply to state agencies located at ARC, and to private entities located in areas of this site that are not under exclusive jurisdiction

12.2.5.2. California Native Plant Protection Act

The CNPPA of 1977 prohibits importation of rare and endangered plants into California, take of rare and endangered plants, and sale of rare and endangered plants. CESA defers to the CNPPA, which ensures that state-listed plant species are protected when state agencies are involved in projects subject to the California Environmental Quality Act (CEQA). In this case, plants listed as rare under the CNPPA are not protected under CESA but rather under CEQA.

The following kinds of activities are exempt from the California Native Plant Protection Act:

- Agricultural operations
- Fire control measures
- Timber harvest operations
- Mining assessment work
- Removal of plants by private landowners on private land for construction of canals, ditches, buildings, roads, or other rights-of-way
- Removal of plants for performance of a public service by a public agency or a publicly or privately-owned public utility

While CEQA does not apply directly to federal agencies, ARC does consider the impacts on state listed species during NEPA analyses. CEQA does apply to state agencies located at ARC.

12.2.6. LOCAL LAWS

12.2.6.1. Santa Clara County Heritage Tree Ordinance

The Santa Clara County Heritage Tree Ordinance is designed to protect trees in order to provide aesthetic beauty, economic vitality, and environmental stability for county lands. Protected trees generally include:

- Trees that are 95.8 centimeters (37.7 inches) or more in circumference (30 centimeters [12 inches] in diameter) at 137 centimeters (4.5 feet) above ground
- Multiple trunk trees with a total of 192 centimeters (75.4 inches) in circumference (61 centimeters [24 inches] in diameter of all trunks within the following areas of the county:
    - Parcels zoned “hillside” that are 3 acres or less
    - Parcels within a “-d” (Design Review) combining zoning district
    - Parcels within the Los Gatos Specific Plan Area

Any heritage tree, as defined by the Tree Preservation Ordinance

- Any tree required to be planted as a replacement for an unlawfully removed tree
- Any tree required to be planted or retained by the conditions of approval for any use permit, building site approval, grading permit, architectural and site approval, design review, special permit, or subdivision
- Any tree that meets the minimum measurements and occurs on any property owned or leased by the County of Santa Clara
- Any tree, regardless of size, within road rights-of-way and easements of the county, whether within or outside of the unincorporated territory of the county

The ordinance requires that project proponents take into account the location of all heritage trees on a property when new building or outdoor space is planned. Development plans must preserve and minimize disturbance to as many trees as possible. Heritage trees can only be removed if approved by the county. The removal of any heritage trees must be mitigated by planting replacement trees at a ratio determined by the Santa Clara County Planning Department.

12.3. REGIONAL SETTING

ARC is located in northern Santa Clara County at the southern end of the San Francisco Bay. U.S. Highway 101, adjacent to the southern boundary of the ARC, provides primary transportation access to the facility. ARC is part of the metropolitan Bay Area; San Francisco is located 65 kilometers (40 miles) to the northwest, and San Jose is located 16 kilometers (10 miles) to the southeast. The cities of Mountain View and Sunnyvale are adjacent to ARC, across U.S. Highway 101. The USFWS owns the salt ponds and marshes north of Moffett Field, which were previously used for salt production by Cargill Salt Company. North of the USFWS property is the San Francisco Bay, approximately 1.6 kilometers (1 mile) to the north of Moffett Field. No direct hydrologic connection links the facility and the waters of San Francisco Bay, although there is limited connection to Guadalupe Slough (through gates and pumps), located to the northeast of Moffett Field, through the Northern Channel and Moffett Channel.

12.4. EXISTING SITE CONDITIONS

The following sections discuss existing plant resources at the ARC. Sections are organized geographically. The first three sections discuss resources in the NASA Research Park (NRP) and Ames Campus areas, the Bay View area, and the Eastside/Airfield area, respectively. A fourth section summarizes resources immediately north of the Bay View area, adjacent to but outside of the area, referred to herein as the North of Bay View area.

Table 12.1 includes lists special-status plant species that occur or may occur in the Ames Research Center area. Based on research and analysis conducted during preparation of the NASA Ames Development Plan Final Programmatic Environmental Impact

Statement, there are no designated critical habitat areas within or near the ARC (Design, Community & Environment 2002). All of the existing habitat areas in the vicinity have been extensively disturbed by agriculture and development over the past two centuries.

12.4.1. NASA RESEARCH PARK AND AMES CAMPUS AREAS

The NRP and Ames Campus areas are both highly urbanized areas of the ARC site. The bulk of development has occurred in these two areas. As a result, what little habitat remains is disturbed and fragmented. Existing resources within the NRP and existing ARC Campus areas are very similar and, therefore, are addressed together.

12.4.2. VEGETATION

Habitat types in the NRP and Ames Campus areas include weed-dominated areas, disturbed areas, and urban landscaped areas. Figure 12-1 shows the distribution of these habitat types.

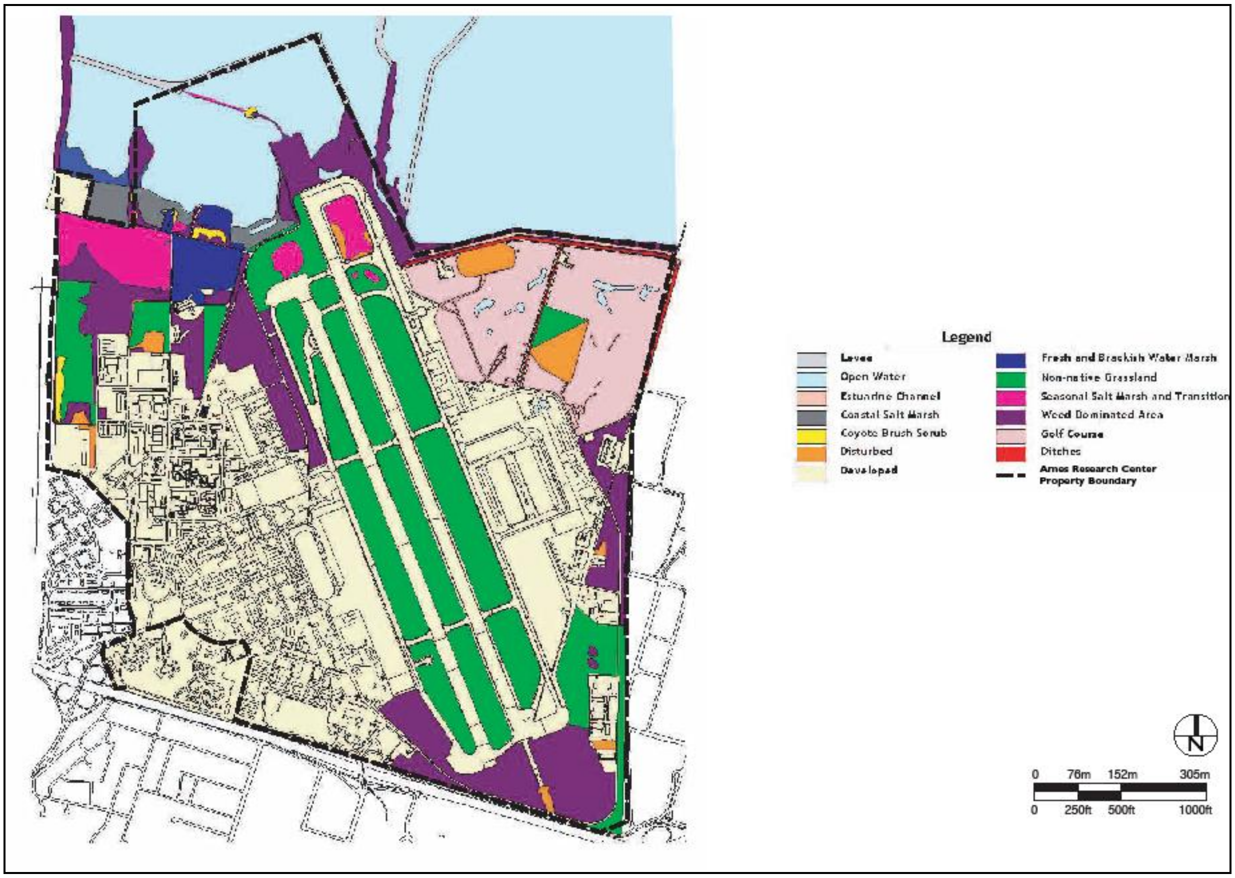

Figure 12-1 Distribution of Vegetation Areas

12.4.2.1. Weed-Dominated Areas

Weed-dominated habitat occurs along roadsides and in undeveloped infill parcels in the NRP and existing Ames Campus areas. Extensive development has contributed to the establishment of weedy species; in many cases, weed-dominated areas are mowed or exhibit the effects of other past disturbance.

This habitat type is generally dominated by nonnative annual herbs, primarily bristly ox-tongue (*Picris echiodes*), scattered geranium (*Geranium dissectum*), and nonnative annual grasses (*Avena* spp., *Polypogon monspeliensis*, *Hordeum* spp., and *Vulpia* spp.). These sites may also support invasive exotic weeds that crowd out native species and create a monoculture habitat with little value to wildlife. The dominant species in this habitat may alternate between nonnative grasses and weedy herbs, depending on the season, amount of rainfall, and maintenance activities (for example, mowing).

Table 12-1 Special-Status Plants That Potentially Occur at the NASA Ames Research Center

Common and Scientific Name	Status* Fed./State/ CNPS	California Distribution	Habitats	Flowering Period	Occurrence in Study
Hairless popcornflower *Plagiobothrys glaber*	-/-/IA	Presumed extinct (presumed extirpated in Alameda, Marin, Merced, San Benito, and Santa Clara).	Alkaline meadows, coastal marshes. Elevation: 15–180 meters (19–590 feet)	March–May	No records of species in study area. Highly unlikely to occur; presumed extinct.
Point Reyes bird's-beak *Cordylanthus maritimus palustris*	SSC/-/1B	Humboldt, Marin, and Sonoma; presumed extirpated in Alameda, San Mateo, and Santa Clara.	Coastal bluff scrub, coastal dunes, coastal prairie, coastal scrub. Elevation: 5–550 meters (16–1,805 feet)	June–October	No records of species in study area. Suitable habitat is present in salt and brackish marshes in study area.
Robust spineflower *Chorizanthe robusta var. robusta*	SSC/-/1B	Marin, San Francisco, San Mateo, Santa Clara, and Sonoma; presumed extirpated in Alameda.	Coastal bluff scrub, coastal dunes, coastal prairie, coastal scrub. Elevation: 5–550 meters (16–1,805 feet)	May–September	No records of species in study area. Suitable habitat may be present. Highly unlikely to occur; thought to be extirpated from San Francisco Bay area.
San Francisco Bay spineflower *Chorizanthe cuspidata var. cuspidata*	SSC/-/1B	Marin, San Francisco, San Mateo, Santa Clara, and Sonoma; presumed extirpated in Alameda.	Coastal bluff scrub, coastal dunes, coastal prairie, coastal scrub. Elevation: 5–550 meters (16–1,805 feet)	April–August	No records of species in study area. Suitable habitat is sparse or absent; species is unlikely to occur in study area.
San Joaquin spearscale *Atriplex joaquiniana*	SSC/-/1B	Alameda, Contra Costa, Glenn, Merced, Monterey, Napa, Sacramento, San Benito, Solano, and Yolo; presumed extirpated in San Joaquin, Santa Clara, and Tulare.	Chenopod scrub, meadows, playas, alkaline valley, and foothill grasslands. Elevation: 5–550 meters (16–1,805 feet)	April–October	No records of species in study area. Suitable habitat is sparse or absent; species is unlikely to occur in study area.

*Status Explanations

Federal Status:	State Status:
SSC = species of concern	E = listed as endangered under the California Endangered Species Act
E = listed as endangered under the federal Endangered Species Act	T = listed as threatened under the California Endangered Species Act
T = listed as threatened under the federal Endangered Species Act	CR = listed as rare under the California Endangered Species Act
- = no designation	- = no designation

Source: Design, Community and Environment 2002.

12.4.2.2. Disturbed Areas

Disturbed areas are common in the undeveloped regions between buildings and along roadsides in NRP and Ames Campus areas. Disturbed areas may exhibit altered topography resulting from past or present fill or excavation and are commonly covered with debris. These areas are significantly altered from their original habitat type. In many cases, they are almost bare or are dominated by ruderal species. Weedy species that may be found in this habitat type include the invasive exotic perennial pepperweed (*Lepidium latifolium*).

12.4.2.3. Urban Landscaped Areas

Urban landscaping includes ornamental trees, shrubs, and turf grasses that were intentionally planted around the buildings in the NRP area and the Ames Campus. Most species are nonnative and require irrigation and regular maintenance. Species planted in these areas include lawn grasses, juniper (*Juniperus* spp.), cypress (*Cypressus* spp.), and domestic roses (*Rosa* spp.). In 2007 and 2008, native gardens were established at the Center. Located west of N-269l, and to the north of N-235, these gardens include a vast array of native plants.

12.4.2.4. Special-Status Plants

No special-status plants are known or expected to occur in the NRP or Ames Campus planning areas because of their highly urbanized nature (EIS).

12.4.2.5. Bay View Area

The Bay View area is less developed than other parts of ARC. As a result, it supports more native habitat types. However, despite its more natural appearance, the Bay View area has been subject to disturbance, resulting in the development of nonnative grasslands and weed-dominated areas. For example, areas that now support coyote brush scrub and nonnative grassland habitats were previously under cultivation and were affected by farming practices, including disking and plowing, until the 1980s (Alderete, personal communication in Design, Community & Environment 2002).

12.4.2.6. Vegetation

Habitats in the Bay View area include seasonal salt marsh and transition, coyote brush scrub, nonnative grassland, weed-dominated areas, disturbed areas, and urban landscaped areas. Figure 12-1 shows the distribution of these habitat types.

12.4.2.7. Seasonal Salt Marsh and Transition

Seasonal salt marsh is found in the wetlands north of the Bay View area and along the border between these wetlands and the Bay View area. Only a very small extent of seasonal salt marsh and transitional habitat is actually within the Bay View area (approximately 2.1 hectares [5.3 acres]).

Seasonal salt marsh occurs on the uppermost edges of coastal salt marsh habitats and includes vegetation that is transitional between the salt marsh and adjacent uplands or structural elements (roads, levees, and dikes). At lower elevations, seasonal salt marsh is dominated by pickleweed (*Salicornia virginica*), alkali heath (*Frankenia salina*), and salt grass (*Distichlis spicata*). Black mustard (*Brassica nigra*) and Australian saltbush (*Atriplex semibaccata*) are present along berms and in other elevated areas. In some areas, perennial pepperweed may exceed 50% cover. Its presence indicates the displacement of native plant species and reduction in habitat value for wildlife.

12.4.2.8. Coyote Brush Scrub

At the ARC, areas of coyote brush scrub include regions that have been disturbed in the past or have been subjected to repeated disturbances over time. In the Bay View area, this habitat type occurs on the western boundary of the ARC, along West Perimeter Road.

In coastal areas, coyote brush (*Baccharis pilularis*) is often one of the first native shrub species to colonize disturbed upland areas and sometimes forms dense stands. Dense stands of coyote brush are categorized as coyote brush scrub. The overstory of coyote brush scrub is dominated by coyote brush. The species composition of the herbaceous plants in the understory is similar to that of adjacent habitats (nonnative grassland or weed-dominated areas). At the ARC, other shrub and tree species were also observed in some stands of coyote brush scrub, including the native elderberry (*Sambucus mexicana*) and nonnative ornamental olive (*Olea* spp.) and acacia (*Acacia* spp.).

12.4.2.9. Nonnative Grassland

A large portion of the Bay View area along the west boundary of the ARC (West Perimeter Road) is nonnative grassland habitat. Areas classified as nonnative grasslands are dominated by nonnative grasses, including annual Mediterranean grasses such as Mediterranean rye (*Lolium multiflorum*), wild oats (*Avena* spp.), bromes (*Bromus* spp.), and rattail fescue (*Vulpia myuros*). Another common species, creeping red fescue (*Festuca rubra*), is a nonnative perennial grass. Nonnative herbaceous species contribute less than 20% of vegetation cover in nonnative grasslands; they include bristly ox-tongue, birdfoot trefoil (*Lotus corniculatus*), field bindweed (*Convolvulus arvensis*), and milk thistle (*Silybum marianum*).

12.4.2.10. Weed-Dominated Areas

The Bay View area supports weedy habitats similar to those in the NRP and existing ARC Campus areas. Weed-dominated habitat in the Bay View area occurs along roadsides and in open spaces between development sites. It may also occur as patches enclosed by other habitat types. Some weed-dominated habitats in the Bay View area include areas where moist soil supports an increased diversity of nonnative weedy species. In some locations, large stands of invasive exotic species such as kikuyu grass (*Pennisetum clandestinum*), periwinkle (*Vinca* major), and perennial pepperweed are present. Kikuyu grass is abundant on berms, roadsides adjacent to coastal salt marsh, and freshwater and brackish marsh habitats. Figure 12-1 shows the location of a large stand of periwinkle. The presence of these species is notable because they are all highly invasive and have the potential to displace vegetation that is more desirable. If not controlled, these invasive species will continue to spread into surrounding habitats.

12.4.2.11. Other Habitat Types

Other habitat types are sparsely represented in the Bay View area. Because there has been little development in the area, currently disturbed areas are limited to a few empty lots between buildings. However, there is urban landscaping around the buildings in this area.

12.4.2.12. Special-Status Plants

No special-status plants are known or expected to occur in the Bay View area because of its highly urbanized nature.

12.4.2.13. Eastside/Airfield

The airfield and its accompanying hangars and support buildings occupy the majority of the Eastside/Airfield area. Other land uses in the area include office buildings and the golf course.

12.4.3. VEGETATION

Habitats in the Eastside/Airfield area include estuarine channel, seasonal wetland, seasonal salt marsh, nonnative grassland, weed-dominated areas, disturbed areas, and a golf course.

12.4.3.1. Estuarine Channel

The northern channel is a storm drain channel that contains shallow water habitats that exhibit estuarine characteristics. USFWS ponds to the north may influence adjacent tidal wetlands. The channel runs along the northern boundary of the Eastside/Airfield area and is separated from the North Patrol Road by an armored chain link fence and the East Patrol Road Ditch. The northern channel's saltwater influx is contributed by the San Francisco Bay, and becomes seasonally diluted by freshwater runoff that enters the channel. The channel's shore supports emergent hydrophytic vegetation that provides habitat for a variety of waterbirds, including salt marsh common yellowthroat (*Geothlypis trichas sinuosa*) and common moorhen (*Gallinula chloropus*). The channel also supports several fish and invertebrate species, including bay shrimp, crab and mosquito fish and longjaw mudsucker (*Gallinula chloropus*). Freshwater gastropod shells have been found in the channel, suggesting that the winter influx of fresh water supports populations of snails (Montgomery Watson 1997).

12.4.3.2. Seasonal Wetland

The seasonal wetlands in the Eastside/Airfield area are located on the airfield itself and in several ditches on and adjacent to the golf course. Because of their low elevation and proximity to salt water, these wetlands may be slightly brackish or alkaline. Vegetation in this habitat type is a mosaic of large patches of Baltic rush (*Juncus balticus*), creeping wild rye (*Leymus triticoides*), and cattails (*Typha* spp.). Other species include spearscale (*Atriplex triangularis*), salt grass, clustered field sedge (*Carex praegracilis*), and nonnative perennial pepperweed.

12.4.3.3. Seasonal Salt Marsh

In the Eastside/Airfield area, seasonal salt marsh habitats occur in constructed ditches. The ditches are located along East Patrol Road and North Patrol Road adjacent to the golf course. They represent a unique habitat because their steep banks and the long-term availability of water support the development of several narrow, linear vegetation zones adjacent to one another.

The ditch along North Patrol Road has steep banks, and wetland vegetation is limited to the lower portions of the banks, immediately above the water line. The dominant plant species in the wetland portions of the North Patrol Road ditch include pickleweed, salt grass, and prairie bulrush (*Scirpus maritimus*). Adjacent uplands support the nonnative herbaceous species birdfoot trefoil and yellow sweet clover (*Melilotus inducus*) and the nonnative grasses rattail fescue and Mediterranean canary grass (*Phalaris minor*). Cattails and bulrushes (*Scirpus* spp.) form patches of emergent vegetation.

The ditch along the East Patrol Road is slightly wider and has more gently sloping banks than the North Patrol Road ditch. During the field surveys in August and September 2000, surface water was present only in a ponded area at the northern end of the ditch. The East Patrol Road ditch supports much less vegetation than the North Patrol Road ditch, and it is dominated by nonnative dallis grass (*Paspalum dilatum*) and litter, with a few stands of prairie bulrush.

12.4.3.4. Other Habitat Types

Nonnative grasslands, weed-dominated areas, and disturbed areas are also present in the Eastside/Airfield area. They occur between developed parcels, along roads, and in open fields.

12.4.3.5. Golf Course

The golf course provides irrigated, grassy, open habitat for small mammals and the predators that prey on them. Both California ground squirrels (*Spermophilus beecheyi*) and western burrowing owls (*Athene cunicularia hypugea*) are numerous. The golf course also encompasses permanent ponds and stormwater runoff ditches that are supplied with brackish water.

12.4.3.6. Special-Status Plants

No special-status plants are known or expected to occur in the Eastside/Airfield area because of its highly urbanized nature.

12.4.3.7. North of Bay View Area

Immediately north of the Bay View area is a tract of high-quality wetland habitat that is rich in vegetation and wildlife. This region, referred to as the North of Bay View area, is within the ARC jurisdiction, but has been excluded from future development because of the special-status species it supports or may support, and because of the presence of jurisdictional wetlands.

The North of Bay View wetland area contains the most diverse and least disturbed habitats at the ARC, including coastal salt marsh, seasonal salt marsh and transition, freshwater and brackish marshes, coyote brush scrub, unvegetated areas (including open water), and disturbed areas. Habitat suitable for many special-status plants and wildlife occur or may occur in the North of Bay View area. Surveys have been conducted for delta tule pea (*Lathyrus jepsonii* var. *jepsonii*), hairless popcornflower (*Plagiobothrys glaber*), Point Reyes bird's-beak (*Cordylanthus maritimus* ssp. *palustris*), and California sea-blite (*Suaeda californica*). To date, none of these species has been observed.

12.5. ENVIRONMENTAL MEASURES

The following are existing environmental commitments that are currently being implemented to protect sensitive and special-status plants at the ARC:

- To minimize impacts on wetlands, construction would be avoided in the jurisdictional wetlands along the northern boundary of the Bay View area and within 30 meters (100 feet) of these wetlands. Fill activities and other disturbances would be minimized in jurisdictional wetlands elsewhere in the Eastside/Airfield area.

- A wetland enhancement plan would be developed for the restoration of functions and values of aquatic habitats in and adjacent to the Bay View area and outside of development area. This plan would include provisions to improve the quality of existing wetlands in the Bay View area through removal of invasive nonnative plants such as periwinkle and perennial pepperweed. This enhancement plan would be developed in coordination with, and would be approved by, the Corps and the San Francisco Bay Regional Water Quality Control Board prior to implementation of the proposed action. All construction near or adjacent to wetlands would implement standard best management practices (BMPs) to minimize runoff into these sensitive areas. Implementing grading and construction during the driest months of the year (July-October) would reduce the potential for siltation and runoff into surrounding habitats.
- Landscaping would be designed with native species (with the possible exception of lawn areas). Invasive plants would not be used in any landscaping. Any imported soil used for landscaping must be certified as weed-free. Similarly, any erosion-control structures that contain hay or other dried plant material (for example, hay bales) must be certified as weed-free. Any construction equipment operating within 76 meters (250 feet) of jurisdictional wetlands or other sensitive habitats in the Bay View area would be washed with reclaimed water prior to use in this area to remove potential weed seeds. The construction zone would be surveyed periodically by a qualified botanist so that any infestations of invasive species that establish within the construction zone of the Bay View area can be eradicated before the plants can flower and set seed.
- Potentially contaminated runoff would be managed using stormwater BMPs. Swales would be constructed adjacent to wetlands in upland areas to intercept and filter any runoff before it reaches the wetland. Construction of swales would be permitted within the buffer zone around wetlands, but not within the wetlands themselves.
- To minimize impacts on wetlands, construction would be avoided in the jurisdictional wetlands along the northern boundary of the Bay View area and within the buffer zone of these wetlands. Fill activities and other disturbances would be avoided in jurisdictional wetlands elsewhere in the Eastside/Airfield area.

12.5.1. MITIGATION MEASURES

The NASA Ames Development Plan (NADP) Final Programmatic Environmental Impact Statement (FEIS) identified the mitigation measures to address potential vegetation and wetland impacts from build out of Mitigated Alternative 5 in the NADP

(Design, Community & Environment 2002). For a full discussion of impacts and mitigation measures related to the NADP, see the FEIS.

Chapter 13. Fish and Wildlife

13.1. OVERVIEW

This chapter provides information about biological resources at ARC, including the types and distribution of habitat, wildlife, and special-status species. Applicable regulations pertaining to protected wildlife are discussed, as are existing measures and programs that ARC has implemented to protect wildlife. The information presented in this chapter was drawn from the results of biological studies that have been previously conducted at ARC, as well as the NASA Ames Development Plan Final Programmatic Environmental Impact Statement (Design, Community & Environment 2002), and the Storm Water Retention Pond Tidal Restoration Feasibility Study (2005).

13.2. REGULATORY REQUIREMENTS

This section describes relevant federal and state regulations of biological resources.

13.2.1. FEDERAL LAWS

The federal laws that regulate the treatment of biological resources are the Endangered Species Act of 1973, as amended (ESA), the Migratory Bird Treaty Act (MBTA), the Bald and Golden Eagle Protection Act, and the National Environmental Policy Act (NEPA). The following sections discuss the relevant portions of each of them.

13.2.1.1. Endangered Species Act

ESA protects fish and wildlife species that are listed as threatened or endangered, and their habitats. "Endangered" species, subspecies, or distinct population segments are those that are in danger of extinction through all or a significant portion of their range, and "threatened" species, subspecies, or distinct population segments are likely to become endangered in the near future. The U.S. Fish and Wildlife Service administers ESA.

Section 7

Section 7 of ESA requires federal agencies to ensure that their actions do not jeopardize the continued existence of a listed fish or wildlife species, or destroy or adversely modify that species' critical habitat, as defined and designated by federal regulations. Federally listed species that are known to occur at the facility include California brown pelican, California clapper rail, California least tern, western snowy plover, and salt marsh harvest mouse.

Section 9

Section 9 of ESA prohibits the take of any fish or wildlife species listed as endangered under the act. As defined by ESA, "take" means "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." "Harm" is defined as "any act that kills or injures the species, including significant habitat modification." Take of threatened species is also prohibited unless otherwise authorized by federal regulations

13.2.1.2. Migratory Bird Treaty Act

The federal MBTA, administered by the U.S. Fish and Wildlife Service, implements a series of treaties between the United States, Mexico, and Canada that provide for the international protection of migratory birds. The law contains no requirement to prove intent to violate any of its provisions. Wording in the act makes it clear that most actions that result in "taking" or possession (permanent or temporary) of a protected species can be a violation of the act. In the MBTA, the word "take" is defined as meaning "pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to pursue, hunt, shoot, wound, kill, trap, capture, or collect." The provisions of the MBTA are nearly absolute, "except as permitted by regulations." Examples of permitted actions that do not violate the law are the possession of a hunting license to pursue specific game birds, legitimate research activities, display in zoological gardens, bird-banding, and similar activities (Faanes et al. 1992 in Design, Community & Environment 2002).

13.2.1.3. Bald and Golden Eagle Protection Act

Bald eagle protection began in 1940 with the passage of the Eagle Protection Act. The Eagle Protection Act was later amended to include the golden eagle and was renamed. The Bald and Golden Eagle Protection Act makes it unlawful to import, export, take, sell, purchase, or barter any bald eagle or golden eagle, their parts, products, nests, or eggs. Take includes pursuing, shooting, poisoning, wounding, killing, capturing, trapping, collecting, molesting, or disturbing. The U.S. Fish and Wildlife Service for may grant exceptions for scientific or exhibition use, or for traditional and cultural use by Native Americans. However, no permits may be issued for import, export, or commercial activities involving eagles.

13.2.1.4. National Environmental Policy Act

NEPA of 1969 requires federal agencies to include in their decision-making process appropriate and careful consideration of all environmental effects of a proposed action and of possible alternative actions. Measures to avoid or minimize the adverse effects of proposed actions and to restore and enhance environmental quality as much as possible must be developed and discussed where feasible.

13.2.2. State Laws

The most relevant state laws regulating biological resources are the California Endangered Species Act and the California Fish and Game Code, each of which is described below.

13.2.2.1. California Endangered Species Act

The California Endangered Species Act protects wildlife and plants listed as threatened and endangered by the California Fish and Game Commission. California Department of Fish and Game administers the act. The act requires state agencies to conserve threatened and endangered species (Section 2055), and thus restricts all persons from taking listed species except under certain circumstances. The act defines "take" as any action or attempt to "hunt, pursue, catch, capture, or kill." The California Department of Fish and Game may authorize take under Section 2081 agreements, except for designated "fully protected species." The requirements for an application for an incidental take permit under the California Endangered Species Act are described in Section 2081 of the California Fish and Game Code and in final adopted regulations for implementing Sections 2080 and 2081.

13.2.2.2. California Fish and Game Code

The California Fish and Game Code provides protection from take for a variety of species. Section 5050 lists protected amphibians and reptiles, eggs and nests of all birds are protected under Section 3503, nesting birds (including raptors and passerines) under Sections 3503.5 and 3513, birds of prey under Section 3503.5, and fully protected birds under Section 3511. All birds that occur naturally in California and are not resident game birds, migratory game birds, or fully protected birds are considered non-game birds and are protected under Section 3800. Mammals are protected under Section 4700. Hawks, falcons, and owls that occur at ARC are thus protected under Section 3503.5 and non-game birds under Section 3800. In addition, several bird species listed under Section 3511, including golden eagles and white-tailed kites, occur or have the potential to occur in ARC. Specific measures to avoid take of western burrowing owl, a protected bird of prey, are incorporated into the Western Burrowing Owl Habitat Management Plan written for NASA by Dr. Lynne Trulio (2001 in Design, Community & Environment 2002).

13.3. REGIONAL SETTING

ARC is in northern Santa Clara County at the southern end of the San Francisco Bay. U.S. Highway 101, adjacent to the southern boundary of the facility, provides primary transportation access to the facility. Ames is part of the metropolitan Bay Area; San Francisco is located 65 kilometers (40 miles) to the northwest and San Jose is located 16 kilometers (10 miles) to the southeast. The cities of Mountain View and Sunnyvale are adjacent to Ames, across U.S. Highway 101. The U.S. Fish and Wildlife Service owns the salt ponds and marshes north of Moffett Field previously used for salt production by Cargill Salt Company. North of the U.S. Fish and Wildlife Service property is the San Francisco Bay, approximately 1.6 kilometer (1 mile) to the north of Moffett Field. No direct hydrologic connection links the facility and the waters of San Francisco Bay, although there is limited connection to Guadalupe Slough (through gates and pumps), located to the northeast of Moffett Field, through the Northern Channel and Moffett Channel.

13.4. EXISTING SITE CONDITIONS

The following sections discuss existing biological resources at ARC. Sections are organized geographically. The first three sections discuss resources in the NASA Research Park (NRP) and Ames Campus, the Bay View area, and the Eastside/Airfield area, respectively. A fourth section summarizes resources immediately north of the Bay View area, adjacent to but outside of the area, referred to herein as the North of Bay View area.

Vertebrate animal life at ARC largely consists of migratory and wintering birds, visiting birds from the nearby bay front and open water habitats, and several resident species of birds and small mammals. Approximately 14 endangered or threatened species are known to frequent the site.

Species listed as Federally Endangered or Threatened are fully protected under the provisions of ESA. Unlike threatened and endangered species, Federal Candidate Species and Federal Species of Special Concern are not afforded any legal protection under ESA but typically receive special attention from federal and state agencies during the environmental review process. Species listed on the state level include State Endangered, California Fully Protected, and California Species of Special Concern. All state and federal special-status species potentially found at ARC are summarized in Table 13-1 and are discussed in detail below.

As has been documented in recent environmental reports, there are no designated critical habitat areas within or near ARC. All of the existing habitat areas in the vicinity have been extensively disturbed by agriculture and development over the past two centuries.

Table 13-1 Special-Status Wildlife That Potentially Occur at the NASA Ames Research Center

Common and Scientific Name	Status* Fed/State	California Distribution	Habitats	Reasons for Decline	Occurrence in Study
Invertebrates					
Vernal pool fairy shrimp *Branchinecta lynchi*	T/	Vernal pools and seasonal wetlands of the Central Valley.	Vernal pools and other seasonal aquatic habitats.	Habitat loss as a result of dredging and filling; poor water quality.	No recorded observations in study area. Study area is likely outside range of species.
Bay checkerspot butterfly *Euphydryas editha bayensis*	T/	Lowlands of Santa Clara, San Mateo, Alameda, Contra Costa, and San Francisco counties, on serpentine soils.	Serpentine soil outcrops that support host plants—*Plantago erecta*, *Castilleja densiflorus*, and *Castilleja exserta*.	Habitat loss as a result of urbanization and fragmentation.	No suitable habitat is present in the study area.
Amphibians					
California red-legged frog *Rana aurora draytonii*	T/SSC	Coast and coastal mountain ranges of California from Humboldt County south to San Diego County; Sierra Nevada (above 1,000 feet) from Butte to Fresno counties.	Permanent and semipermanent aquatic habitats (such as creeks and coldwater ponds) with emergent and submergent vegetation and riparian species along the edges; may estivate in rodent burrows or cracks during dry periods.	Alteration of stream and wetland habitats; historical overharvesting; habitat destruction; competition and predation by nonnative fish and bullfrogs.	No recorded observations in study area (Layne and Harding-Smith 1995; Scott and Alderete 2001. Unlikely to occur in study area because no suitable habitat exists: water sources are saline and/or seasonal, and water quality is low. Predators are abundant.

Common and Scientific Name	Status* Fed/State	California Distribution	Habitats	Reasons for Decline	Occurrence in Study
California tiger salamander *Ambystoma califomiense*	C/SSC	Central Valley, including Sierra Nevada foothills to elevations of approximately 1,000 feet; coastal region from Butte County south to Santa Barbara County.	Larvae use small ponds, lakes, or vernal pools in grasslands and oak woodlands; adults use rodent burrows, rock crevices, or fallen logs for cover and estivation.	Loss of grasslands, vernal pools, and other wetlands as a result of agricultural development and urbanization.	No recorded observations in study area (Layne and Harding-Smith 1995; Scott and Alderete 2001). Unlikely to occur in study area because no suitable habitat exists: water sources are saline and/or seasonal, and water quality is low. Predators are abundant.
Western spadefoot *Scaphiopus hammondii*	SC/SSC	Sierra Nevada foothills, Central Valley, Coast Range, and coastal counties in southern California.	Shallow streams with riffles; seasonal wetlands, such as vernal pools in annual grasslands and oak woodlands.	Alteration of stream habitats by urbanization and hydroelectric projects; loss of seasonal wetlands and vernal pools.	No recorded observations in study area. No suitable habitat is present, and study area is likely outside range of species.
Reptiles					
Alameda whipsnake *Masticophis lateralis euryxanthus*	T/T	Valleys, foothills, and low mountains in Alameda and Contra Costa counties.	Oak woodland, northern coastal scrub, and or chaparral; requires rock outcrops for cover and foraging.	Limited range and restricted habitat; habitat loss as a result of urban development; predation by domestic and feral cats.	No recorded observations in study area. Study area is likely outside range of species.
California horned lizard *Phrynosoma coronatum frontale*	SC/B	Lowlands throughout California.	Sandy washes with open areas for sunning, bushes for cover, and loose soil for burrowing; near abundant food sources (ants and other insects).	Urban encroachment on habitat.	Not observed in study area; suitable habitat is sparse or absent. Nearest recorded observation was on Mount Hamilton.

Common and Scientific Name	Status* Fed/State	California Distribution	Habitats	Reasons for Decline	Occurrence in Study
Western pond turtle *Clemmys marmorata*	SC/SSC	West of the Sierra-Cascade crest from sea level to elevations of approximately 6,000 feet.	Woodlands, grasslands, and open forests; occupies ponds, marshes, rivers, streams, and irrigation canals with muddy or rocky bottoms and vegetation to provide cover and food.	Loss and alteration of aquatic and wetland habitats; habitat fragmentation.	Turtles have been observed in the Northern Channel and Marriage Road Ditch in Eastside/Airfield.
Birds					
Alameda song sparrow *Melospiza melodia pusillula*	B/SSC	Southern San Francisco Bay area.	Forages and takes cover in taller vegetation along tidal sloughs; breeds in salt marshes.	Habitat loss resulting from dredging, diking, and filling of marsh habitats.	May occur in the study area in wetlands in North of Bay View area (outside of planning areas). Difficult to distinguish from other subspecies that occur in the area.
Bald eagle *Haliaeetus leucocephalus*	T(PR)/E	Year-round resident of mountain regions of northern California; winters throughout the state except for southern high-desert regions and parts of central inland California.	Uses ocean shorelines, lake margins, and river courses for nesting and foraging. Colonial nester; requires large or old-growth trees. Commonly nests in ponderosa pines.	Habitat loss as a result of urbanization.	May occur in study area. Nearest recorded observation was at Guadalupe River, foraging in summer and fall.
Bank swallow *Riparia riparia*	BIT	Resident in riparian and coastal settings in northern and northeastern California; migrates throughout the state. Only remaining resident coastal colonies in the state are located at Fort Funston and Point Ailo Nuevo.	Coastal cliffs, inland bluffs, and riverbanks; prefers riparian and other lowland habitats; usually found along aquatic habitat. Colonial nester; requires vertical banks with soft substrate for digging nest sites.	Habitat loss as a result of urbanization.	No records of species in study area. Rarely observed in South San Francisco Bay Area.

Common and Scientific Name	Status* Fed/State	California Distribution	Habitats	Reasons for Decline	Occurrence in Study
Western burrowing owl *Athene cunicularia hypugea*	SC/SSC	Lowlands throughout California, including the Central Valley, northeastern plateau, southeastern deserts, and coastal areas; rare along the south coast.	Uses rodent burrows in sparse grassland, desert, and agricultural habitats.	Habitat loss; human disturbance at nesting burrows.	Many nests have been recorded in upland habitats of the study area, within planning areas.
California brown pelican *Pelecanus occidentalis*	E/E	Along the coast from British Columbia to Central America. Breeding populations in Monterey County.	Coastal areas; on rocky shores and cliffs, in sloughs, and in coastal river deltas. Occasionally in inland lakes.	DDT contamination; overfishing of prey fish; human development around breeding and foraging habitat.	Nonbreeding foragers observed in wetlands in North of Bay View area (outside of planning areas); also roosts on pond levees.
California clapper rail *Rallus longirostris obsoletus*	E/T	Salt and brackish marshes along San Francisco Bay.	Salt marshes with multiple tidal channels and vegetation dominated by cordgrass, pickleweed, and marsh gumplant.	Habitat loss and alteration as a result of filling, diking, and dredging.	Observed along Stevens Creek tidal slough (outside planning areas) and in North of Bay View.
California least tern *Sterna antillarum browni*	E/E	Nests in San Francisco Bay and in coastal areas from San Luis Obispo County south to San Diego County. Largest concentrations of breeding pairs nest in Los Angeles, Orange, and San Diego counties. Sometimes seen around Salton Sea.	Sandy areas with sparse vegetation; mud flats; gravel substrates above high water.	Habitat loss as a result of human encroachment; predation; dredging, filling, and pollution of estuarine habitats.	Observed foraging and roosting in wetlands in North of Bay View area (outside of planning areas). May also nest on site.

Common and Scientific Name	Status* Fed/State	California Distribution	Habitats	Reasons for Decline	Occurrence in Study
Cooper's hawk *Accipiter cooperii*	B/SSC	Throughout California except at high elevations in the Sierra Nevada. Wintering populations use the Central Valley, the southeastern desert regions, and the plains east of the Cascade Range.	Nests primarily in riparian forests dominated by deciduous species; also nests in densely canopied forests from foothill pine-oak woodland up to ponderosa pine; forages in open woodlands.	Human disturbance at nest sites; loss of riparian habitats, especially in the Central Valley; pesticide contamination.	No recorded observations in the study area. Suitable habitat is sparse or absent.
Golden eagle *Aquila chrysaetos*	PR/SSC	Foothills and mountains throughout California; uncommon nonbreeding visitor to the lowlands, including the Central Valley.	Nests in cliffs and escarpments or in tall trees; forages in annual grasslands, chaparral, and oak woodlands with plentiful medium-sized and large mammals for prey.	Habitat loss as a result of urbanization.	Has been observed in the study area. Grasslands on site may provide suitable foraging habitat.
Loggerhead shrike *Lanius ludovicianus*	B/SSC	Grasslands throughout the state.	Forages in grassland or ruderal habitats.	Loss of grassland habitat as a result of urban expansion.	Foraging behavior and nest sites have been documented in wetlands in North of Bay View area (outside of planning areas). May occur in similar habitats within planning areas.
Northern harrier *Circus cyaneus*	B/SSC	Marshes, fields, grasslands, and prairies throughout North America.	Coastal salt and freshwater marshes. Nests on ground in shrubby vegetation, usually near marsh edge or in grasslands; forages in grasslands.	Habitat loss as a result of urbanization and agricultural development; pesticide contamination.	Observed in wetlands in North of Bay View area (outside of planning areas).

Common and Scientific Name	Status* Fed/State	California Distribution	Habitats	Reasons for Decline	Occurrence in Study
American peregrine falcon *Falco peregrinus anatum*	delisted/E	In California, breeding range now includes the Klamath and Cascade ranges, the inland north-coastal mountains, the Sierra Nevada, and the Channel Islands.	Wetlands, grasslands, and tundra, in open forest, and in mountains. Prefers sites near open areas but with nearby cliffs for nesting and roosting; will occasionally nest on the ledges of tall buildings or bridges in cities.	Pesticide contamination; robbing of eyries by falconers; illegal shooting; human disturbance at nest sites.	May occur in study area. Foraging habitat is present but no suitable nesting habitat exists in the study area.
Salt marsh common yellowthroat *Geothlypis trichas sinuosa*	B/SSC	Fresh and brackish marshes of the San Francisco Bay Area.	Freshwater and brackish marshes with emergent vegetation.	Habitat loss resulting from dredging, diking, and filling of marsh habitats.	Foraging and nesting sites have been documented in wetlands in North of Bay View area (outside of planning areas).
Tricolored blackbird *Agelaius tricolor*	SC/B	From southern Oregon south through California's Central Valley and into Baja California.	Cattail and tule marshes; open valleys and foothills.	Habitat loss resulting from dredging, diking, and filling of marsh habitats.	May occur in wetlands in North of Bay View area (outside of planning areas). Nearest observations are near the Guadalupe River.
Western least bittern *Ixobrychus exilis hesperis*	SC/B	Breeds in parts of the Central Valley and inland northern California. Resident populations occur on the southernmost coast and from the Salton Trough and lower Colorado River regions south into Baja California and mainland Mexico.	Freshwater and brackish marshes with dense, tall aquatic or semi-aquatic vegetation. Colonial nester; nests in low tules, over water.	Habitat loss as a result of urbanization.	No records of species in study area; species is a rare visitor to nearby marshes in winter.

Common and Scientific Name	Status* Fed/State	California Distribution	Habitats	Reasons for Decline	Occurrence in Study
Western snowy plover *Charadrius alexandrinus mvosus*	T/SSC	Beaches and coastal settings from southern Washington to southern Baja California, and some inland playa lakes, primarily in California.	Sandy coastal beaches and margins of inland playas; prefers flat, bare, or sparsely vegetated substrates, particularly light-colored substrates.	Human disturbance; habitat loss.	Observed foraging in wetlands in North of Bay View area (outside of planning areas).
White-faced ibis *Plegadis chihi*	B/SSC	Year-round resident of Salton Trough; winters in parts of Central Valley, on the south coast, and from the lower Colorado River region south into coastal mainland Mexico.	Shallow freshwater marshes offering dense tule thickets for nesting and areas of shallow water for foraging.	Decline of suitable habitat.	No records of species in study area. Rare migrant or winter visitor in the San Francisco Bay area.
Marbled murrelet *Brachyramphus marmoratus*	TIE	Marine subtidal and pelagic habitats and coastal coniferous forests from the Oregon border to Imperial Beach, San Diego County.	Old-growth conifer (especially redwood and Douglas-fir) forests near the coast.	Habitat loss resulting from logging of old-growth forests; loss of individuals from oil spills and other contaminants.	No suitable habitat is present in study area.
California black rail *Laterallis jamaicensis coturniculus*	T/	San Francisco Bay area, Sacramento-San Joaquin delta, coastal southern California (including Morro Bay), Salton Sea, and Lower Colorado River area.	Saline, brackish, and freshwater emergent wetlands.	Significant loss of salt and freshwater wetland habitat. Loss of higher-elevation wetlands around San Francisco Bay has eliminated breeding in the area.	Suitable habitat is present in North of Bay View area (outside of planning areas).
Horned lark *Eremophila alpestris aetia*	/SSC	Coastal California from Sonoma county southeast to the Mexican border, including San Joaquin Valley and Sierra Nevada foothills.	Open habitats with few trees, including: level or gently sloping short-grass prairies, montane meadows, coastal plains, fallow grain fields, and alkali flats.	Loss and fragmentation of habitat resulting from urbanization; mortality resulting from pesticide contamination and mowing.	Occurs in the Bay View planning area and in wetlands in North of Bay View area (outside of planning areas).

Common and Scientific Name	Status* Fed/State	California Distribution	Habitats	Reasons for Decline	Occurrence in Study
American white pelican *Pelecanus erythrorhynchos*	/SSC	Coastal bays and estuaries, inland lakes.	Open water habitats.	Habitat loss in inland areas; pesticide (DDT) poisoning; decline in water quality.	Occurs in open water habitats in North of Bay View area (outside of planning areas).
White-tailed kite *Elanus leucurus*	SC/SSC	Year-round resident in Oregon and California, except at high elevations.	Low rolling foothills and valley margins with scattered oaks for nesting and perching; river bottomlands and associated marsh habitats; open grasslands.	Habitat loss as a result of urbanization.	Nests locally; known to occur in wetlands in North of Bay View area (outside of planning areas).

Common and Scientific Name	Status* Fed/State	California Distribution	Habitats	Reasons for Decline	Occurrence in Study
			Mammals		
Salt marsh harvest mouse *Reithrodontomys raviventris*	E/B	Saline wetlands of San Francisco Bay. Southern subspecies *(R. r. raviventris)* occupies San Mateo, Alameda, and Santa Clara counties.	Salt marsh habitat that supports large stands of pickleweed.	Habitat loss resulting from dredging and filling of pickleweed marshes around San Francisco Bay.	Occurs in pickle weed-dominated salt marshes in the North of Bay View area (outside of planning areas).
San Joaquin kit fox *Vulpes macrotis mutica*	E/E	Valley floor and adjacent low foothills of the San Joaquin Valley.	Open grasslands	Habitat loss resulting from agriculture and urbanization.	No recorded observations in study area. Study area is likely outside range of species.
Riparian brush rabbit *Sylvilagus bachmani riparius*	E/E	Riparian forests along San Joaquin and Stanislaus rivers in Stanislaus and San Joaquin counties.	Dense, brushy areas of valley riparian forests not subject to regular or heavy flooding.	Habitat resulting from dam construction for irrigation and flood control on the major rivers of the Central Valley.	Probably extirpated from the area.
Salt marsh wandering shrew *Sorex vagrans halicoetes*	SC/B	Southern San Francisco Bay area.	Salt marshes 6 to 8 feet above sea level, where abundant driftwood is scattered among pickleweed.	Habitat loss resulting from dredging, diking, and filling of marsh habitats.	No recorded observations in the study area. Suitable habitat exists in surrounding salt marshes (outside the planning areas).
Western mastiff bat *Eumops perotis*	SC/SSC	Eastern San Joaquin Valley from El Dorado County south through Kern County; Coast Ranges, Peninsular Range, and Transverse Ranges from San Francisco to the Mexican border.	Roosts and breeds in deep, narrow rock crevices; may also use crevices in trees, buildings, and tunnels. Forages in a variety of semiarid to arid habitats.	Unclear; possibly insecticide contamination and loss of foraging habitat; possibly disturbance of roosting sites.	No recorded observations in study area; no suitable habitat is present.

Common and Scientific Name	Status* Fed/State	California Distribution	Habitats	Reasons for Decline	Occurrence in Study
Townsend's western big-eared bat *Plecotus townsendii townsendii*	SC/SSC	Coastal regions from Del None County south to Santa Barbara County.	Roosts in caves, tunnels, mines, and dark attics of abandoned buildings.	Unclear; possibly human disturbance of roosting sites.	No recorded observations in study area. Buildings on site may provide roosting habitat, although current levels of use make the potential for roosting low.
Pallid bat *Antrozous pallidus*	B/SSC	At low elevations throughout California.	Roosts in rocky outcrops, cliffs, and crevices; requires access to open habitats for foraging.	Human disturbance of roosting sites.	No recorded observations in study area. May forage over wetland and riparian areas in Bay View, North of Bay View, and Eastside/Airfield.
Fringed myotis *Myotis tbysanodes*	SC/	Coastal regions of California.	Primarily associated with trees; sometimes roosts in buildings. Forages in vegetation, along forest edges, and over forest canopies.	Unclear; possibly human disturbance of roosting sites.	No recorded observations in study area. Buildings on site may provide roosting habitat, although current levels of use make the potential for occurrence low.
Long-eared myotis *Myotis evotis*	SC/	Coastal regions of California, Sierra Nevada, Cascades, and Great Basin from Oregon to the Tehachapi Mountains.	Observed roosting in buildings and under bridges. Forages along rivers and streams, over ponds, and within cluttered forest environments	Unclear; possibly human disturbance of roosting sites.	No recorded observations in study area. Buildings on site may provide roosting habitat, although current levels of use make the potential for roosting low. May forage over wetland and riparian areas in Bay View, North of Bay View, and Eastside/Airfield.

Common and Scientific Name	Status* Fed/State	California Distribution	Habitats	Reasons for Decline	Occurrence in Study
Long-legged myotis *Myotis volans*	SC/	Coast Ranges and Sierra Nevada, and Great Basin regions.	Associated with forest habitats. Reported to day roost in buildings. Forages over open areas.	Unclear; possibly human disturbance of roosting sites. Lack of forest habitat.	No recorded observations in study area. Buildings on site may provide roosting habitat, although current levels of use make the potential for roosting low. May forage over wetland and riparian areas in Bay View, North of Bay View, and Eastside/Airfield.

*Status Explanations

Federal Status:	State Status:
E = listed as endangered under the Federal Endangered Species Act	E = listed as endangered under the California Endangered Species Act
T = listed as threatened under the Federal Endangered Species Act	T = listed as threatened under the California Endangered Species Act
SC = species of concern	SSC = species of special concern
= no designation	- = no designation

13.4.1. NRP Ames Campus Areas

This section describes common and special-status wildlife species found in the NRP and Ames Campus areas. The NRP and Existing ARC areas are both highly urbanized areas of the ARC site. The bulk of development has occurred in these two areas and, as a result, what little habitat remains is disturbed and fragmented. Existing resources within the NRP and Ames Campus areas are very similar and, therefore, are addressed together.

13.4.1.1. Common Wildlife

Common species of wildlife found in these areas consist of species that are adaptable to human presence and disturbance, such as skunks (*Mephitis mephitis*), raccoons (*Procyon lotor*), and opossums (*Didelphis virginiana*). Also common are feral cats (*Felis catus*), which substantially disturb natural wildlife communities by predation. Small mammals, such as California ground squirrels (*Spermophilus beecheyi*), western harvest mice (*Reithrodontomys megalotis*), deer mice (*Peromyscus maniculatus*), and house mice (*Mus musculus*), are abundant and provide a significant prey base for these predators. Ornamental trees and shrubs create habitat for common bird species, such as European starling (*Sturnus vulgaris*), mourning dove (*Zenaida macroura*), Brewer's blackbird (*Euphagus cyanocephalus*), sparrow (*Zonotrichia* spp.), and house finch (*Carpodacus mexicanus*).

13.4.1.2. Special-Status Animals

Western Burrowing Owl

Because of the highly urbanized nature of these areas, only one special-status animal, the western burrowing owl (*Athene cunicularia hypugea*), is known or expected to occur in the NRP and Ames Campus areas.

Burrowing owls have been listed as a California Species of Concern since 1978, so direct impacts to either the birds or their nests are prohibited. In addition, the California Fish and Game Code prohibits the take, possession, or destruction of birds, their nests, or their eggs. Burrowing owls are also listed as a Federal Species of Concern.

Burrowing owls are small brown and white mottled owls with bright lemon-yellow eyes and long, unfeathered legs. They are approximately 18 to 25 centimeters (7 to 10 inches) tall, and weigh on average 3 to 4 ounces (150 grams). They range from Mexico to Canada. Of all of the 171 species of owls worldwide, the burrowing owl is the only one that nests underground.

Burrowing owls usually move into burrows that other animals have abandoned rather than digging their own, and thus usually live within colonies of small burrowing animals. In Northern California, burrowing owls live primarily in ground squirrel colonies. They not only use burrows that ground squirrels have abandoned as nests, but also depend on the squirrels to graze down the vegetation around burrows to short grass or even dirt, which is the owl's preferred habitat.

Typical burrowing owl habitat is open, dry, sparsely vegetated terrain. The availability of burrows is the most critical element. Owls' choice of burrows is affected by several key factors, such as the percentage of vegetative cover and the height of vegetation surrounding the burrow mouth, soil texture, and the presence of perches suitable for keeping watch for predators. At ARC, the typical vegetation height around burrows is 6.9 centimeters (2.7 inches) and the typical area of vegetative cover is 57%, as opposed to 26 centimeters (10.4 inches) and 85% in areas where no owls are found.

Historically, burrowing owls were found in natural areas of open prairie or open shrub-steppe habitat. Human population growth and land use changes have destroyed much of their original habitat, however, so burrowing owls now commonly nest in the perimeters of agricultural fields, irrigation ditches, fallow fields, open fields prepared for development, airports, golf courses, military bases, and parks. They have become quite tolerant of human presence as long as suitable nesting and foraging habitat exist.

Some burrowing owls are migratory, while others live in roughly the same area year round. Whether they migrate out or just move a small distance, burrowing owls often return to the same or nearby nest burrows each spring to breed. Once owls have chosen a nest burrow, they are loath to leave it, which can make it very difficult to relocate them. All of the relocation attempts that have been studied have had low success rates (Design, Community & Environment 2002).

Burrowing owls are active during both day and night. By day, they stand by their nest burrow guarding against predators. At night they do most of their feeding. They prey primarily on large insects and small rodents. Burrowing owls forage in ruderal, manicured, or natural grasslands. While they do most of their foraging within 91 meters (300 feet) of their burrows, recent research (Design, Community & Environment 2002) also indicates that owls may forage as far as 4.8 kilometers (3 miles) from their burrows in the evening.

Burrowing owls are themselves prey for a number of aerial and ground species, including hawks, falcons, coyotes, snakes, skunks, raccoons, feral cats, and loose dogs. The major unnatural causes of death for owls include effects from pesticides, predation by nonnative and feral animals, destruction of nests by surface disturbances (such as grading), and collisions with cars since owls generally fly low to the ground.

Currently, the western burrowing owl is declining throughout much of its western North American range. It is endangered in Minnesota, Iowa, and throughout its range in Canada. It is a Species of Concern in six states, including California. The extensive destruction of prairie dogs and ground squirrels (whose colonies it usually shares), the use of pesticides and herbicides, and the conversion of grasslands to agricultural and urban uses have all contributed to the burrowing owl's declining numbers.

The burrowing owl was once a relatively common grassland bird in California. Although owls still occur in much of their pre-1940s range in California, the species no longer breeds in Marin, San Francisco, Santa Cruz, Napa, coastal San Luis Obispo, or Ventura counties. Only one to two breeding pairs exist in each of Sonoma, Santa Barbara, Orange, coastal Monterey, and San Mateo counties.

The South San Francisco Bay region, which includes Santa Clara and Alameda counties, lost a substantial portion of its owl population during the explosive development of the 1980s, and numbers are still declining. The region currently supports a population of approximately 120 breeding pairs of burrowing owls. ARC supports one of the largest subpopulations, with roughly 25 breeding pairs. The relatively large size of ARC's burrowing owl population makes it an anchor for the entire region. The survival of this population may thus be critical to the long-term persistence of burrowing owls in the region.

Burrowing owls have thrived at ARC for four main reasons. First, ARC's federal ownership has largely protected the land from the rampant development that has destroyed much of the owl habitat in the rest of Santa Clara County. A second reason is that ARC is closed to the public, preventing much human disturbance of owl burrows and foraging areas. Thirdly, short grass habitat has been maintained as part of standard maintenance procedures. Finally, ground squirrels are not controlled throughout much of ARC, which leaves burrowing owls their essential habitat requirements, ground squirrels and their burrows.

To protect the burrowing owl population at ARC, a Western Burrowing Owl Habitat Management Plan was prepared in 1999 by Dr. Lynne Trulio, a burrowing owl expert. This report presents management techniques for protecting owls and owl habitat, relocating predators, and minimizing the impact of any new projects ARC's owl population. The recommendations of this report have been incorporated into the Preferred Alternative for the NASA Ames Development Plan.

13.4.2. BAY VIEW AREA

This section describes common and special-status wildlife species in the Bay View area. The Bay View area is less developed than other parts of ARC and, as a result, it supports more native habitat types. However, despite its more natural appearance, the Bay View area has been subject to disturbance, resulting in the development of nonnative grasslands and weed-dominated areas. For example, areas that now support coyote brush scrub and nonnative grassland habitats were previously under dryland cultivation and were affected by farming practices, including disking and plowing, until the 1980s (NASA 1994).

13.4.2.1. Common Species

The Bay View area supports a variety of wildlife. Common and dominant species include many birds that use coyote brush scrub, nonnative grassland, and the willows in the wetter areas. These species include song sparrow (*Melospiza melodia*), white-crowned sparrow (*Zonotrichia leucophrys*), golden-crowned sparrow (*Zonotrichia atriacapilla*), lesser goldfinch (*Carduelis psaltria*), American goldfinch (*Carduelis tristis*), Brewer's blackbird, western meadowlark (*Sturnella neglecta*), marsh wren (*Cistothorus palustris*), Bewick's wren (*Thryomanes bewickii*), and house finch. Raccoons, opossums, and skunks are common mammals in this area. Nonnative red foxes (*Vulpes vulpes*) and feral cats are also frequently seen. Small mammals supply an abundant prey base; they include burrowing species, such as pocket gophers (*Thomomys bottae*), and larger lagomorphs, such as black-tailed hares (*Lepus californicus*).

Because of the Bay View area's proximity to wetland and open water habitats, and the intermittent presence of a small extent of open water within the Bay View area, migratory waterfowl are common.

13.4.2.2. Special-Status Animals

The following special-status animal species have been observed in the Bay View area.

Salt Marsh Common Yellowthroat

The salt marsh common yellowthroat (*Geothlypis trichas sinuosa*) is a California Species of Special Concern. It is a small warbler that resides in the marshes of the San Francisco Bay area. During the breeding season (March to late July), it can be found in marshes from Sonoma, Napa, Solano, and Marin counties south to Santa Clara County. This species uses both wetland and upland vegetation for foraging and nesting. Salt marsh common yellowthroats are rare at ARC, although they are observed in the freshwater and brackish marshes and adjacent habitats both within and north of the Bay View area.

Loggerhead Shrike

The loggerhead shrike (*Lanius ludovicianus*) is a state and federal Species of Special Concern. It is a common resident and winter visitor in lowlands and foothills throughout California, and prefers open habitats offering scattered shrubs, trees, posts, fences, utility lines, or other perches. A small number of loggerhead shrikes have been observed in the Bay View area in the upland habitats adjacent to the freshwater and brackish marshes.

White-Tailed Kite

White-tailed kites (*Elanus leucurus*) are fully protected under Section 3511 of the California Fish and Game Code. This species is a year-round resident of low rolling foothills and valley margins throughout California, and often forages for birds and small mammals in open grassland and marsh habitats. White-tailed kites are common at ARC. Individuals of the species have been observed in courtship behavior, indicating that breeding may occur on site, and nests have been found in the North of Bay View area.

Western Burrowing Owl

Burrowing owls are uncommon in the Bay View area, but can be found in Shoreline Regional Park to the west of ARC.

Northern Harrier

Northern harriers (*Circus cyaneus*) are fully protected under Section 3511 of the California Fish and Game Code. They are large raptors that occupy coastal salt and freshwater marshes. Northern harriers often forage in grasslands and fields that surround the marsh north of the Bay View area, and they are seen regularly in the Bay View area.

Golden Eagle

The golden eagle (*Aquila chrysaetos*) is a California Species of Special Concern and is protected under the federal Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act. The golden eagle feeds mainly on rabbits and on California ground squirrels (*Spermophilus beecheyi*). Pairs typically nest on cliffs or in trees, preferably near grasslands where prey is available. Golden eagles have been observed in the Bay View area, and foraging habitat is available in the area's nonnative grasslands and weed-dominated habitats.

Horned Lark

The horned lark (*Eremophila alpestris aetia*) is a California Species of Special Concern. Horned larks occur in open habitats with few trees. As a result, they can utilize grazed prairies and meadows and can tolerate some human disturbances related to farming and clearing. A few horned larks have been observed in the Bay View area.

American Peregrine Falcon

The American peregrine falcon (*Falco peregrinus anatum*) is state-listed as endangered. Peregrine falcons nest on ledges in tall vertical cliffs and other rocky outcrops secure from predators. The species forages on a variety of birds and small mammals in both terrestrial and wetland habitats. Suitable foraging habitat exists throughout the annual grasslands and weed-dominated portions of ARC. However, ARC does not offer suitable nesting habitat for the species, so the species is uncommon within it.

13.4.3. EASTSIDE/AIRFIELD

This section describes common and special-status wildlife species found in the Eastside/Airfield area. The airfield and its accompanying hangars and support buildings occupy the majority of the Eastside/Airfield area. Other land uses in the area include office buildings and the golf course. The golf course provides irrigated, grassy, open habitat for small mammals and the predators that prey on them. Both California ground squirrels and burrowing owls are numerous. The golf course also encompasses permanent ponds and stormwater runoff ditches that are supplied with brackish water, providing habitat for a small population of western pond turtles.

13.4.3.1. Common Species

Common and dominant wildlife species that occur in the Eastside/Airfield area are similar to those found in the NRP and Ames Campus areas. In addition, the migratory waterfowl present in the most of the Bay View area utilize the seasonal wetlands in the northern portion of the airfield when enough rain falls to fill them. The prey base of small mammals (particularly California ground squirrels [*Spermophilus beecheyi*]) in the Eastside/Airfield is large, and many raptors have been seen hunting here, including the peregrine falcon (*Falco peregrinus anatum*), golden eagle (*Aquila chrysaetos*), and white-tailed kite (*Elanus leucurus*).

13.4.3.2. Special-Status Animals

The following special-status animal species occur or may occur in the Eastside/Airfield area.

Western Burrowing Owl

Because of the large population of California ground squirrels, burrowing owls are common in the Eastside/Airfield area and on the Lockheed Martin property to the east of ARC.

Western Pond Turtle

The western pond turtle (*Clemmys marmorata*) is a California Species of Special Concern. Pond turtles are found in quiet waters of lowland and foothill ponds, streams, marshes, and reservoirs. They require upland habitat for breeding. A pond turtle may travel long distances upslope from a permanent or nearly permanent water source to lay its eggs in grassland or scrub habitat. Turtles have been observed in the Northern Channel and Marriage Road Ditch in Eastside/Airfield. ARC has developed a habitat management plan to protect the western pond turtle population.(Alderete 2004).

California Red-Legged Frog

The California red-legged frog is federally listed as Threatened and is a California Species of Special Concern. The species requires permanent or semi-permanent aquatic habitats with emergent and submergent vegetation. Red-legged frog surveys were conducted in 1994 (Layne and Harding-Smith 1994), but no frogs or larvae have been detected.

Suitable habitat for the California red-legged frog may occur in ponds and ditches on the golf course. However, salinity levels in these ponds are normally within the lethal range for developing red-legged frog embryos and larvae. Because of the lack of suitable habitat and the presence of predators, California red-legged frogs are considered very unlikely to occur in the Eastside/Airfield area.

California Tiger Salamander

The California tiger salamander is a candidate for federal listing and is a California Species of Special Concern. Tiger salamanders are terrestrial and spend most of their time underground in small-mammal burrows, emerging only for brief periods to breed. Breeding is known to occur in temporary pools and may occur in more permanent bodies of water.

The salinity tolerance of the California tiger salamander is unknown, but may be similar to that of the California red-legged frog. California tiger salamander surveys have been conducted, but no individuals have been observed (Design, Community & Environment 2002). Because of the lack of suitable habitat and the presence of predators, California tiger salamanders are considered very unlikely to occur in the Eastside/Airfield area.

13.4.4. NORTH OF BAY VIEW AREA

Immediately north of the Bay View area is a tract of high-quality wetland habitat that is rich in vegetation and wildlife. This region, referred to as the North of Bay View area, is within ARC jurisdiction, but has been excluded from future development because of the special-status species it supports or may support, and because of the presence of jurisdictional wetlands.

The North of Bay View wetland area contains the most diverse and least disturbed habitats at ARC, including coastal salt marsh, seasonal salt marsh and transition, freshwater and brackish marshes, coyote brush scrub, unvegetated areas (including open water), and disturbed areas. Habitat suitable for many special-status wildlife species occurs or may occur in the North of Bay View area.

Surveys have documented the presence of many special-status wildlife species, including: salt marsh harvest mouse (*Reithrodontomys raviventris raviventris*), California brown pelican (*Pelecanus occidentalis*), California clapper rail (*Rallus longirostris* *obsoletus*), California least tern (*Sterna antillarum browni*), western burrowing owl, golden eagle, loggerhead shrike, northern harrier, peregrine falcon, salt marsh common yellowthroat, western snowy plover (*Charadrius alexandrinus nivosus*), and white-tailed kite. Special-status species that have not been recorded, but for which suitable habitat is present, include Alameda song sparrow (*Melospiza melodia pusillula*), tricolored blackbird (*Agelaius tricolor*), western least bittern (*Ixobrychus exilis hesperis*), salt marsh wandering shrew (*Sorex vagrans haliocoetes*), and bald eagle (*Haliaeetus leucocephalus*).

13.4.5. OTHER SPECIES

In addition to the species described above, there are several federal and state-listed endangered species that do not presently occur at ARC but could because they occur within the general vicinity (within Quad 427B, Milpitas). Operations at ARC have the potential to affect these species should they occur at the site.

The U.S. Fish and Wildlife Service, on behalf of NASA, conducted surveys for the red-legged frog, western snowy plover, California tiger salamander, and salt marsh wandering shrew under its sensitive-species survey at ARC in 1994 (Layne and Harding-Smith 1995). None of the above species was found onsite.

13.5. ENVIRONMENTAL MEASURES

To minimize the potential for injury or death caused by construction vehicles to western burrowing owls or migratory birds in all four planning areas, and to salt marsh harvest mice in the Bay View area, the following components would be implemented:

- As much as possible, construction traffic would not be routed on roads adjacent to habitats where these special-status species occur and would be prohibited from using roads when habitat considerations require it.
- Occupied or potential habitat for these species near established routes would be marked as off-limits to construction vehicles.
- In the Bay View area, if construction vehicles must travel on roads within approximately 30 meters (100 feet) of occupied or potential habitat, drift fencing would be erected to prevent salt marsh harvest mice from crossing these roads. The drift fencing would be placed so that harvest mice retain access to adjacent upland habitats for use as refuge during high water events.
- All drivers of construction vehicles would be informed of the established vehicle routes and made aware of the importance of avoiding occupied and potential habitat for western burrowing owls and salt marsh harvest mice.
- Construction activities would not be allowed to disturb nesting migratory birds.

NASA and its partners would institute the following programs and policies to limit increases in predator populations:

- Prohibit employees from feeding wildlife, including cats
- Institute and enforce a no pets policy in new housing or offices
- Install trash containers that cannot be opened by predator species
- Augment the existing nonnative predator control program, which includes humane trapping and removal of feral cats and other nonnative predators
- Conduct a public education program about the impacts caused by nonnative predators and the need to refrain from feeding feral cats and other wildlife
- A regular construction cleanup crew would be designated to ensure that construction debris and trash do not attract predators or scavengers
- Design north and east fences bordering Bay View housing to eliminate movement of potential predators from the housing area to sensitive wildlife areas. The design would include:
- Burying the bottom portion of the fence at least 46 centimeters (18 inches) below ground level
- Making the fencing grid size small enough to prevent rats from passing through
- Placing roll wire along the top of the fencing to eliminate predators climbing over the fence and to deter avian predators from perching
- To avoid impacts to roosting bats, a qualified wildlife biologist would conduct a preconstruction survey of buildings to be demolished or renovated in accordance with recommendations of the California Department of Fish and Game. If special-status roosting bats are found, the California Department of Fish and Game is to be consulted. An avoidance or mitigation plan would be developed and implemented. Avoidance measures could include construction outside of hibernation and maternal roosting periods (winter), excluding bats from the buildings after they have left the roost to forage at night by closing entrances, and the construction of bat boxes to accommodate displaced bats. If bat boxes were used, NASA would monitor their success
- NASA and its partners would use trash receptors that are animal resistant, and would maintain a regular garbage disposal schedule

- NASA has conducted a lighting study to determine baseline levels. Nighttime lighting would be excluded in new development adjacent to high-quality wildlife habitat in the North of Bay View area. The Bay View housing would not be allowed to cause a net increase in lighting in the areas north or east of Bay View. The impacts of necessary lighting would be minimized by using low-glare light sources for example, low-pressure sodium lighting) mounted on short poles and directed away from native habitats. In addition, light amplification to nearby sensitive areas would be eliminated through directional lighting with baffles, non-reflective tinting on windows, and other mechanisms
- Implementation of the Burrowing Owl Habitat Management Plan and all measures specified in that plan

13.5.1. MITIGATION MEASURES

The NASA Ames Development Plan (NADP) Final Programmatic Environmental Impact Statement (FEIS) identified the mitigation measures to address potential fish and wildlife impacts from build out of Mitigated Alternative 5 in the NADP (Design, Community & Environment 2002). For a full discussion of impacts and mitigation measures related to the NADP, see the FEIS.

Chapter 14. Transportation and Circulation

14.1. OVERVIEW

This section describes the existing transportation characteristics of the ARC and the surrounding area. The transportation system includes the freeways, arterials, bus and rail transit, and bicycle and pedestrian routes that form both the internal network at ARC and the regional network in the surrounding area. Information regarding regulatory requirements, existing transit service, and environmental measures (in Sections 14.2, 14.4.3, and 14.5) was obtained from the NASA Ames Development Plan Final Programmatic Environmental Impact Statement (Design, Community & Environment 2002).

Information regarding existing transportation systems is based on the standards and guidelines of the City of Mountain View, the City of Sunnyvale, and the Santa Clara Valley Transportation Authority (VTA), the congestion management agency for Santa Clara County. Descriptions of the existing transportation system serving ARC and the surrounding area are presented below.

14.2. REGULATORY REQUIREMENTS

Transportation systems serving ARC and the surrounding area are maintained, monitored, or are under the jurisdiction of VTA, the cities of Mountain View and Sunnyvale, Santa Clara County, the California Department of Transportation (Caltrans), and NASA. The following sections discuss the regulatory issues associated with each of these agencies.

14.2.1. LOCAL RULES AND REGULATIONS

This section describes relevant regulations in Santa Clara County and the cities of Mountain View and Sunnyvale.

14.2.1.1. Congestion Management Program

VTA is the congestion management agency for Santa Clara County and implements the Congestion Management Program (CMP). The CMP monitors operations of all freeways and selected expressways and regional arterials through a biennial count program and determines the need for deficiency plans to reduce overall congestion. The CMP facilities in the study area include U.S. Highway 101 (U.S. 101), State Route (SR) 237, SR 85, and Central Expressway.

VTA has also established uniform methods and guidelines for evaluating the transportation impacts of land use decisions on CMP facilities. All of the cities and towns within Santa Clara County have adopted the same transportation impact analysis methodology and significance criteria except for selected areas that are governed by special policies (North San Jose and the Evergreen area in San Jose). This common set of methods and guidelines allows each CMP member agency to understand the impacts of development in adjacent jurisdictions. By projecting against significant impacts to CMP facilities, VTA can better anticipate the effect of land use changes and improve the planning process for the overall regional transportation system. Impacts to CMP facilities must be addressed as part of the environmental review process just as the policies of affected local jurisdictions must be used to determine impact significance.

14.2.1.2. City of Mountain View

The Circulation Chapter/Element of the City of Mountain View General Plan states specific goals, policies, and actions designed to maintain acceptable traffic operations and to reduce congestion. Improved circulation is expected to be provided through enhancement of transit, bicycle, and pedestrian modes, as well as the use of aggressive Transportation Demand Management measures to reduce single-occupant vehicle trips. This document establishes the level of service (LOS) standards for local roadways (LOS D), acknowledges higher levels of congestion on regional roadways (LOS E standard), and includes plans for future bicycle facilities and walkways.

The City of Mountain View and VTA have expressed interest in pursuing a new vehicle connection between the Shoreline Boulevard area (also known as North Bayshore) and Moffett Boulevard. The city has referenced this connection in two previously published documents. Policy 24 under Goal J of the city's general plan is to "reinforce NASA/Ames as an important institutional citizen of Mountain View." Action 24.d under this policy calls for "creation of a link between the North Bayshore area and the entrance to NASA/Ames." Although an existing pedestrian/bicycle connection is currently provided via a bridge at the east end of Charleston Road, the new link is intended to be a full vehicular connection.

A new link between the North Bayshore area and Moffett Boulevard is also referenced in the North Bayshore Area Precise Plan Environmental Impact Report. The analysis conducted in the report indicated that the projected reductions in Shoreline Boulevard traffic with a Charleston Road bridge and a Crittendon Lane bridge would more than offset any increases caused by traffic originating from NASA. Provision of even one bridge was expected to divert more than 50% of the total diverted traffic with both extensions. However, this analysis did not assume redevelopment of the ARC with the land uses proposed under any of the project build alternatives reviewed in the NASA Ames Development Plan Final Programmatic Environmental Impact Statement.

According to City of Mountain View staff, VTA and Caltrans have also expressed interest in a new link on the east side of U.S. 101 to allow for a redistribution of local traffic between the Shoreline Boulevard and Moffett Boulevard interchanges, as well as to reduce the possibility of local trips using the freeway (Design, Community & Environment 2002).

14.2.1.3. City of Sunnyvale

Circulation issues for the City of Sunnyvale are listed in the Land Use and Transportation Element of the city's general plan. The goals, policies, and action statements in this document delineate the operating standard for city streets (LOS D) and regional roadways (LOS E). Specific action items call for participating in coordinated regional land use and transportation planning, supporting alternative modes of transportation, optimizing the use of existing transportation facilities to minimize roadway widenings, and integrating complementary land uses to reduce overall travel and enhance the community environment.

14.2.1.4. Santa Clara County

Santa Clara County maintains roadways in unincorporated areas and expressway facilities. The only county-maintained roadways included in this document are Central Expressway and Manila Drive. The county strives to maintain an LOS D standard for roadway operations and follows the CMP criteria for regional facilities. The addition of an high occupancy vehicle (HOV) lane on the Central Expressway has been identified in the Valley Transportation Plan 2020 published by VTA in December 2000 (Design, Community & Environment 2002).

14.2.2. State Regulations and Policies

Caltrans has jurisdiction over all SRs, including interstate freeways (Interstate 280), U.S. highways (U.S. 101), and state highways (SRs 85 and 237). Caltrans strives to maintain LOS C operations on all of its facilities but acknowledges that numerous roadway segments under its control in urban areas will operate at LOS D or worse (Design, Community & Environment 2002). Any modifications to facilities within the Caltrans right-of-way must be approved by the state. Although impacts to freeway segments are identified as part of the transportation impact analysis process established by VTA, Caltrans can request additional information to determine anticipated impacts to state facilities. Caltrans has an Environmental Review Section to address new developments in local jurisdictions.

14.2.3. Federal Regulations and Policies

Roadways within ARC are under the governance of NASA. Previous publications by the Federal Highway Administration and the Federal Transit Administration indicated that operations of all transportation facilities are typically designed and maintained based on standard engineering practice and may adhere to local standards (Design, Community & Environment 2002). However, the federal government does not employ its own specific standards for intersection operation or other modes that would be used to identify significant environmental impacts. To determine the environmental impacts of its actions, NASA uses the criteria of the local, county, and state jurisdictions.

14.3. REGIONAL SETTING

ARC is located along the southern end of the San Francisco Bay, bounded by USFS ponds to the north, Stevens Creek and the City of Mountain View to the west, U.S. 101 to the south, and the City of Sunnyvale to the east.

U.S. 101 is a major north-south route through the San Francisco Bay area, although it is located on an east-west alignment in the proximity of ARC. The other major freeways within the study area are SR 85 and SR 237. SR 85 is a north-south facility that begins at U.S. 101 just west of ARC, while SR 237 is an east-west facility that intersects with U.S. 101 near the southeast corner of ARC.

The primary access points to ARC are provided along U.S. 101 at the Moffett Boulevard and Ellis Street interchanges. The main gate to ARC is located on Moffett Boulevard, and provides connections to both U.S. 101 and SR 85. A second major gate is located on Ellis Street, and provides a direct connection to U.S. 101. Ellis Street may also be accessed from SR 237 via the Mathilda Avenue interchange and Manila Drive/Moffett Park Drive. Secondary gates are located to the west of Moffett Boulevard (Gate 17) and along the eastern boundary on 5th Avenue west of H Street (Lockheed-Martin gate) (Klim 2000). These routes to ARC are shown on Figure 14-1.

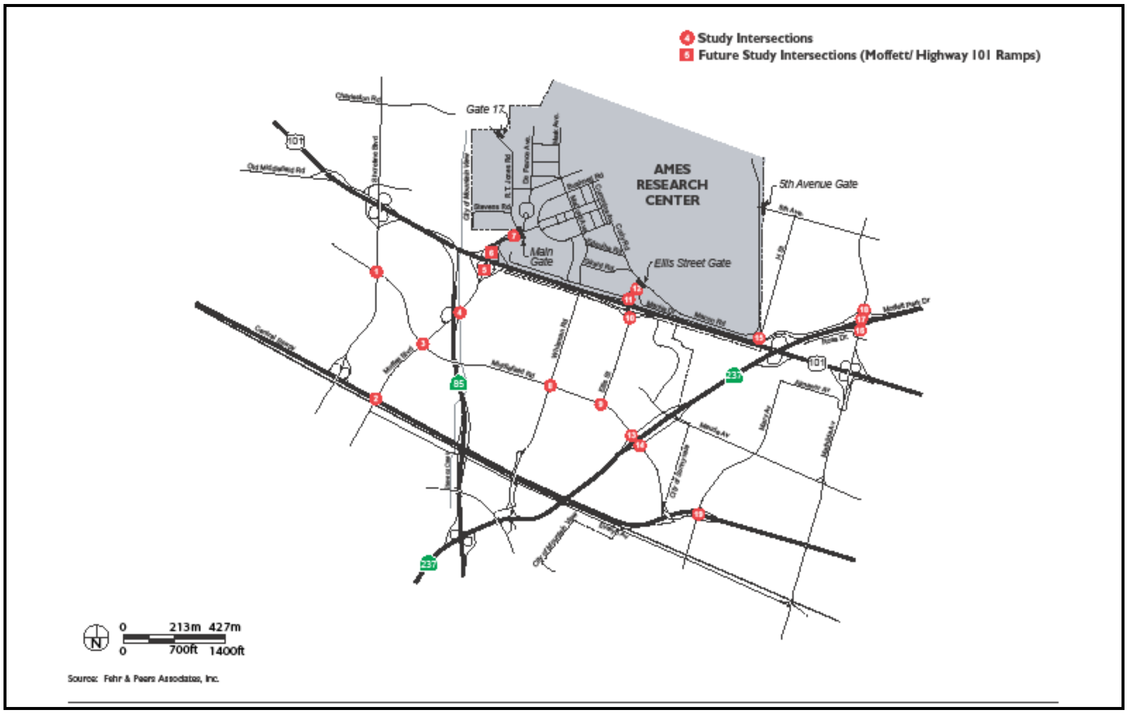

Figure 14-1 Primary Access Points

14.4. EXISTING CONDITIONS

14.4.1. ROADWAY SYSTEM

Information regarding level of service standards and conditions, and existing traffic conditions at the time of the NASA Ames Development Plan Final Programmatic Environmental Impact Statement (EIS) was used to prepare the sections below.

This section describes roadways and intersection conditions within the regional and local vicinities of ARC.

14.4.2. REGIONAL ROADWAY NETWORK

The major regional roadways that are most significant for ARC are summarized below.

14.4.2.1. U.S. Highway 101

U.S. 101 is a major north-south route in California extending from Los Angeles past the Oregon state line. To the north, U.S. 101 provides connections to San Francisco and cities throughout San Mateo County. To the south, it provides connections to Santa Clara and San Jose. In the EIS study area, U.S. 101 has four lanes in each direction, with inside lanes designated as HOV lanes during the peak commute periods on weekdays. CAL TRANS has completed the construction of a new US 101 and SR 85 connector which includes new ramps and HOV lanes for Shoreline Blvd, Old Middlefield Road and access for US 101 and SR 85.

14.4.2.2. State Route 85

SR 85 is a circumferential freeway that originates at U.S. 101 near ARC and goes south then east to rejoin U.S. 101 in south San Jose. From ARC, SR 85 provides connections to Sunnyvale, Cupertino, and southern San Jose. For most of its length, SR 85 is a six-lane facility, with the inside lanes designated as HOV lanes during the peak commute periods. Ramps to and from SR 85 are provided on Moffett Boulevard southeast of U.S. 101.

14.4.2.3. State Route 237

SR 237 is aligned to the southeast of ARC, running between SR 85 and Interstate 680 with connections to U.S. 101 and Interstate 880. On the key segment between U.S. 101 and Interstate 880, SR 237 is primarily a six-lane freeway, with the inside lanes designated as HOV lanes during the peak commute periods. It provides access to ARC from Milpitas to the east, as well as from East Bay further north up Interstates 880 and 680. Access from ARC to SR 237 is typically provided via U.S. 101 from either the Ellis Street or Moffett Boulevard interchanges, although direct access is provided via Manila Drive/Moffett Park Drive and the SR 237/Mathilda Avenue interchange.

14.4.2.4. Moffett Boulevard

Moffett Boulevard is a four-lane arterial that serves as the primary connector into ARC. Regional access to ARC from Moffett Boulevard is provided via interchanges with both U.S. 101 and SR 85 (to and from the south only).

14.4.2.5. Ellis Street

Ellis Street is four-lane arterial running between the South/Ellis Gate at ARC and Middlefield in Mountain View. Between Middlefield and the interchange with U.S. 101, Ellis Street includes marked bicycle lanes in each direction.

14.4.2.6. Manila Drive/Moffett Park Drive

This two-lane roadway runs between Ellis Street and Mathilda Avenue along the edge of ARC. It runs mostly parallel to U.S. 101. It provides access to the new light rail transit station and a connection between ARC and the SR 237/Mathilda interchange.

14.4.2.7. H Street

H Street is a two-lane roadway extending between Manila Drive and 3rd Avenue east of the airfield. This street crosses the VTA light rail line.

14.4.2.8. 5th Avenue

5th Avenue is a two-lane roadway linking Macon Road within the airfield to Borregas Drive east of Mathilda Avenue. A security gate is located at the west end of the street. This street also crosses the VTA light rail line at Mathilda Avenue.

14.4.2.9. Mathilda Avenue

Mathilda Avenue is a multi-lane arterial southeast of ARC with interchanges at both U.S. 101 and SR 237. In conjunction with Manila/Moffett Park Drive, Mathilda Avenue offers an alternative route for accessing these two freeways.

14.4.2.10. Middlefield Road

This two- to four-lane arterial extends through the study area roughly parallel to U.S. 101. Middlefield Road intersects with both Ellis Street and Moffett Boulevard (Klim 2000). Through the study area, Middlefield Road has two lanes in each direction.

14.4.2.11. Central Expressway

Central Expressway is a four-lane limited access arterial extending from southeast of Charleston Road in the City of Palo Alto to De La Cruz Boulevard in the City of Santa Clara. It provides a local alternate to U.S. 101 and includes an at-grade intersection at Moffett Boulevard, as well as grade-separated interchanges at SR 85 (to and from the north only) and Middlefield Road.

14.4.3. LEVEL OF SERVICE

LOS is a qualitative measure for stating the operating quality of a roadway facility, ranging from LOS A (free-flow conditions) to LOS F (congested conditions).

The LOS methodology used in the NASA Ames Development Plan Final Programmatic Environmental Impact Statement follows the standards and guidelines of the cities of Mountain View and Sunnyvale. It also follows the methodologies described in Transportation Impact Analysis Guidelines and Traffic Level of Service Analysis Guidelines produced by VTA. VTA administers the Santa Clara County's CMP and monitors the impact of land use decisions by the member jurisdictions. The methodology for evaluating intersection and freeway performance is described below.

The intersection LOS methodology used to evaluate signalized intersections is the approved VTA methodology, which has been adopted by the cities of Mountain View and Sunnyvale. This method evaluates an intersection's operation based on the average stopped vehicular delay calculated using the procedure described in the 1985 Highway Capacity Manual, with saturation flow rates adjusted to reflect local (Santa Clara County) conditions per VTA guidelines. The average delay for signalized intersections is calculated using the TRAFFIX analysis software, and is correlated to an LOS designation as shown in Table 14-1.

Table 14-1 Signalized Intersection Level of Service Definitions

Level of Service	Average Delay Per Vehicle (Seconds)	Description
A	5.0	Operations with very low delay occurring with favorable progression and/or short cycle length
B+ B B-	5.1 to 7.0 7.1 to 13.0 13.1 to 15.0	Operations with low delay occurring with good progression and/or short cycle lengths
C+ C C-	15.1 to 17.0 17.1 to 23.0 23.1 to 25.0	Operations with average delays resulting from fair progression and/or longer cycle lengths. Individual cycle failures begin to appear
D+ D D-	25.1 to 28.0 28.1 to 37.0 37.1 to 40.0	Operations with longer delays due to a combination of unfavorable progression, long cycle lengths, and high V/C ratios. Many vehicles stop and individual cycle failures are noticeable
E+ E E-	40.1 to 44.0 44.1 to 56.0 56.1 to 60.0	Operations with high delay values indicating poor progression, long cycle lengths, and high V/C ratios. Individual cycle failures are frequent occurrences
F	> 60.0	Operations with delays unacceptable to most drivers occurring due to oversaturation, poor progression, or very long cycle lengths
Sources: VTA 1998 and Transportation Research Board 1985 in Design, Community & Environment 2002		

Operations of unsignalized intersections were calculated using the procedures outlined in the 1997 Update to the Highway Capacity Manual. The LOS rating is based on the average control delay for each minor street movement measured in seconds per vehicle. For all-way stop control intersections, LOS is defined for the intersection as a whole based on a weighted average control delay. Only the worst-case delay is used to identify LOS for two-way stop-controlled intersections (that is, stop signs on the minor street approaches). Table 14-2 presents the range of control delay that corresponds to each LOS designation.

Table 14-2 Level of Service Criteria for Unsignalized Intersections

Level of Service	Average Control Delay per Vehicle (Seconds)
A	10
B	10.1 to 15.0
C	15.1 to 25.0
D	25.1 to 35.0
E	35.1 to 50.0
F	> 50
Source: Transportation Research Board 1994 in Design, Community & Environment 2002	

The method for evaluating freeway operations is based on density expressed as passenger cars per mile per lane. The LOS criteria for freeway operations, shown in

Table 14-3, are based on the criteria from the 1994 Highway Capacity Manual, with some modifications based on an evaluation of field data conducted by VTA.

Table 14-3 Density-Based Freeway Level of Service Criteria

Level of Service	Density (vehicles per mile per lane)
A	10
B	10.0 < density ● 16.0
C	16.0 < density ● 24.0
D	24.0 < density ● 46.0
E	46.0 < density ● 55.0
F	>55.0
Source: VTA 1998 in Design, Community & Environment 2002	

Level of Service Standards

Roadway system deficiencies and impacts are defined as occurring where the calculated LOS falls below the acceptable level of performance. VTA has established LOS E as the standard for signalized intersections on CMP facilities. In general, both Mountain View and Sunnyvale consider LOS D to be the minimum acceptable level of peak-hour operation for signalized intersections on non-CMP routes. In addition, the City of Sunnyvale strives to maintain any existing acceptable LOS (that is, A, B, and C) at intersections where feasible. Neither VTA nor the cities have established a minimum LOS standard for stop sign-controlled intersections. However, typical practice in these jurisdictions has been to accept LOS E operation for a particular movement or shared approach, but to investigate the possibility of signalization in cases where LOS F operations occur or are projected. Caltrans warrant criteria in the Highway Capacity Manual are used to help identify the need for signalization, especially in cases where vehicles on the minor street approaches are expected to experience extensive delay.

Both the cities of Mountain View and Sunnyvale have established LOS D to be the LOS standard for local roadways, and LOS E for regional roadways. Santa Clara County has also established LOS D as the standard for roadways in unincorporated areas and expressway facilities. In addition, Caltrans strives to maintain LOS C operations on all SRs, including Interstate 280, U.S. 101, SR 85, and SR 237.

14.4.3.1. Intersection Level of Service

AM and PM peak-period turning movement counts were conducted during preparation of the NASA Ames Development Plan Final Programmatic Environmental Impact Statement. At the Central Expressway/Mary Avenue intersection, peak-hour count data were obtained from the VTA's 2000 CMP Monitoring and Conformance data files.

The existing volumes were used with the lane configurations to evaluate the current operations of the key intersections.

Only one of the external study intersections currently operates at a deficient level, according to the technical calculations. The Middlefield Road/Shoreline Boulevard intersection operates at LOS E during the PM peak hour, while all other intersections operate at acceptable levels during both peak hours. It should be noted, however, that several locations are considered to operate at worse LOS based on field observations (Design, Community & Environment 2002). For example, at the Moffett Boulevard-Castro Street/Central Expressway intersection, crossing gates closing the south leg of the intersection to accommodate Caltrain passenger rail operations periodically disrupt normal traffic signal cycle operations. This activity increases delay for some movements and worsens overall LOS. It can take several cycles or more for operations to return to normal until the next train requires lowering of the crossing arms.

14.4.3.2. Freeway Level of Service

Freeway segment volumes and LOS were taken directly from the VTA's 2000 Monitoring and Conformance Report.

Several of the freeway segments near ARC operate at LOS F during one or both peak periods. These results illustrate the high level of existing congestion on the area's freeway system, particularly northbound on U.S. 101 (Klim 2000).

14.4.3.3. Internal Roadway Segment Level of Service

With the closure of Moffett Field as a military base, most roadways within ARC carry relatively low volumes of traffic. Peak-period volumes are typically less than 400 vehicles per hour in the peak direction. This level of traffic volume suggests no capacity issues on internal roads (Klim 2000). Observations of key internal intersections also revealed no capacity or delay problems.

In addition, traffic counts were conducted in 1999 at key segments throughout ARC and on local roadways adjacent to the study site, including the ramps at both the Moffett Boulevard and Ellis Street interchanges. Using automated tube counters, 27 segments were counted. Data was collected for a minimum of three midweek days (Tuesday through Thursday) or 72 hours. Table 14-4 summarizes the average weekday daily, AM peak hour, and PM peak hour results for all onsite segments.

14.4.4. BICYCLE AND PEDESTRIAN FACILITIES

Currently, there are bicycle facilities at two locations within ARC. To the north, there are marked bicycle lanes on Wright Avenue between the Moffett Extension and Hunsaker Road. To the south, a separate bicycle path was recently constructed adjacent to Macon Road between Ellis Street and the Lockheed Gate. Throughout the remainder of ARC, the low traffic volumes and the availability of sidewalks and shoulders result in a reasonable environment for cyclists.

The Santa Clara County Bikeways map identifies several bicycle facilities near ARC. To the west, the Stevens Creek Trail intersects with Moffett Boulevard and Middlefield Road, and both cyclists and pedestrians can access ARC via a bridge over the creek and a gate located in the housing area. Moffett Boulevard is a designated bike route between the main gate of ARC and downtown Mountain View. Bike lanes have been marked on Moffett Boulevard and Ellis Street on the west side of U.S. 101 interchanges. Combined, these facilities provide for a high level of bicycle access to ARC. However, there are gaps in the system immediately adjacent to ARC. For example, the bike lanes on both Moffett Boulevard and Ellis Street do not extend through the respective interchanges. This creates a gap leading up to the main gate, and between the Ellis Street bike lanes and the Manila Drive bike lane. Existing bicycle facilities within the EIS study area are shown on Figure 14-2.

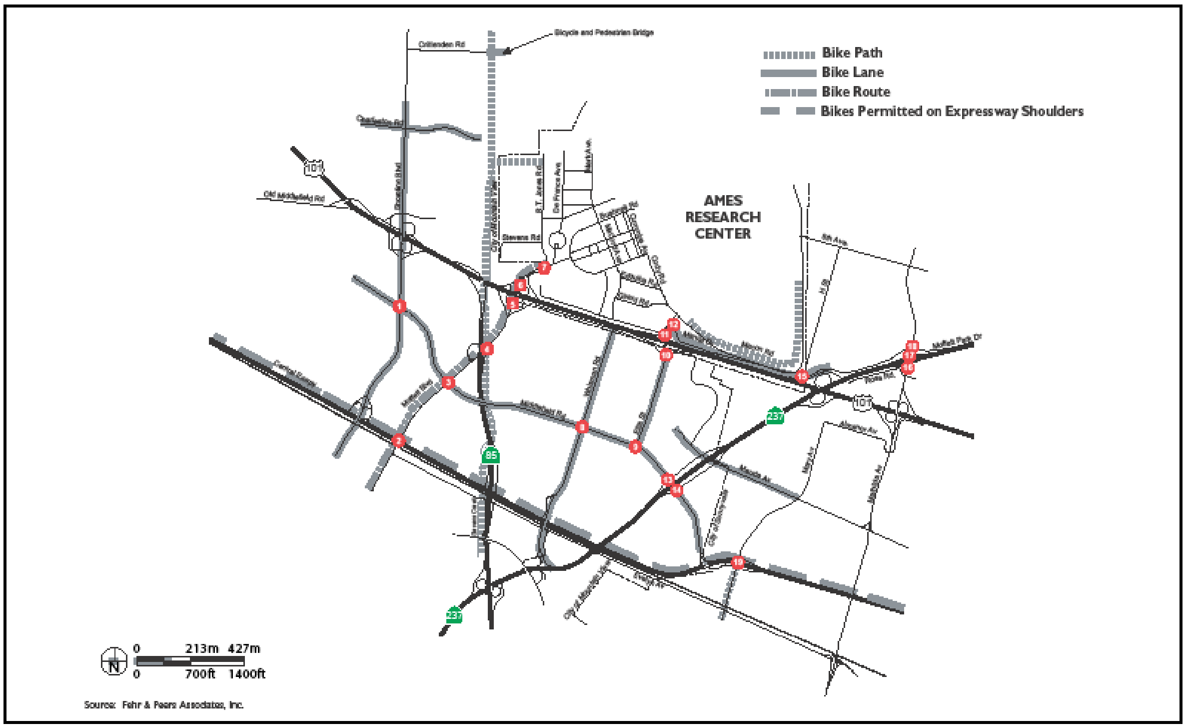

Figure 14-2 Existing Bicycle Facilities

Sidewalks currently exist on many ARC roadways, including most of those within the Ames campus area and the Shenandoah Plaza Historic District. In the remaining area of ARC, the provision of pedestrian facilities is less consistent. For example, there are no sidewalks on Cody Road, and sidewalks are missing on parts of Edquiba and Girard roads. Outside of ARC, sidewalks currently exist on Moffett Boulevard, Ellis Street, and Manila Drive. Similar to the existing bicycle facilities, the lack of exclusive pedestrian facilities across U.S. 101 severely limits the viability of pedestrian activity as an alternative travel mode.

Table 14-4 Existing Signalized Intersection Level of Service

Intersection	Peak Hour	Count Date	Delay	LOS
1. Middlefield Rd./Shoreline Blvd.	AM PM	July 2000 July 2000	37.0 41.5	D E+
2. Moffett Blvd-Castro St./Central Expwy.	AM PM	July 2000 April 2000	31.4 32.5	D D
3. Moffett Blvd./Middlefield Rd.	AM PM	November 1999 November 1999	27.0 25.5	D+ D+
4. Moffett Blvd./Hwy 85 NB Off-Ramp	AM PM	November 1999 November 1999	9.8 5.5	B B+
7. Moffett Blvd.-Clark Memorial Dr./ R.T. Jones Rd. (unsignalized)	AM PM	November 1999 November 1999	14.4 22.8	B C
8. Middlefield Rd./Whisman Rd.	AM PM	July 2000 July 2000	12.5 12.6	B B
9. Ellis St./Middlefield Rd.	AM PM	July 2000 July 2000	11.3 12.3	B B
10. Ellis St./U.S. 101 SB Ramps (unsignalized)	AM PM	November 1999 November 1999	17.4 16.0	C C+
11. Ellis St./U.S. 101 NB Ramps	AM PM	November 1999 November 1999	9.1 8.0	B B
12. Ellis St./Manilla Dr. (unsignalized)	AM PM	November 1999 November 1999	8.1 9.6	A A
13. Middlefield Rd./SR 237 WB Ramps	AM PM	November 1999 November 1999	15.0 14.8	B- B-
14. Middlefield Rd./SR 237 EB Ramps	AM PM	July 2000 July 2000	16.8 12.5	C+ B
15. Manila St./H St.	AM PM	November 1999 November 1999	7.7 7.5	B B
16. Mathilda Ave./SR 237 EB Ramps	AM PM	November 1999 November 1999	14.3 10.9	B- B
17. Mathilda Ave./SR 237 WB Ramps	AM PM	November 1999 November 1999	15.8 20.5	C+ C
18. Mathilda Ave./Moffett Park Dr.	AM PM	November 1999 November 1999	14.8 27.6	B D+
19. Central Expwy./Mary Ave.	AM PM	October 1999 April 2000	50.2 41.8	E- E+

Notes:
1. Whole intersection weighted average stopped delay expressed in seconds/vehicle for signalized intersections, and total control delay in seconds/vehicle for unsignalized intersections.
2. LOS calculations for signalized intersections performed using the 1985 Highway Capacity Manual (Transportation Research Board 1985 in Design, Community & Environment 2002) methodology contained in the TRAFFIX software package with adjusted saturation flow rates to reflect local conditions.
3. LOS calculations for unsignalized intersections performed using the 1997 Highway Capacity Manual (Transportation Research Board 1997 in Design, Community & Environment 2002) methodology contained in the TRAFFIX software package.
4. Intersections 4 and 5 (Moffett Boulevard/Highway 101 NB Ramps and Moffett Boulevard/ Highway 101 SB Ramps) are future intersections to be constructed.

14.4.4.1. Transit Service

Transportation to and from ARC is predominantly by automobile. ARC civil service employees surveyed in 1994 indicated that a majority of employees prefer to drive alone to work. Of those polled, 76% of individuals living within 10 miles of ARC drove alone, and 70% of individuals living up to 30 miles away commute alone (Ames Commute Alternatives Office 1995). ARC policy encourages the minimization of single occupancy vehicle trips to and from the site in conformance with the Bay Area Air Quality Management District's former Regulation 13, Rule 1 (Trip Reduction for Large Employers).

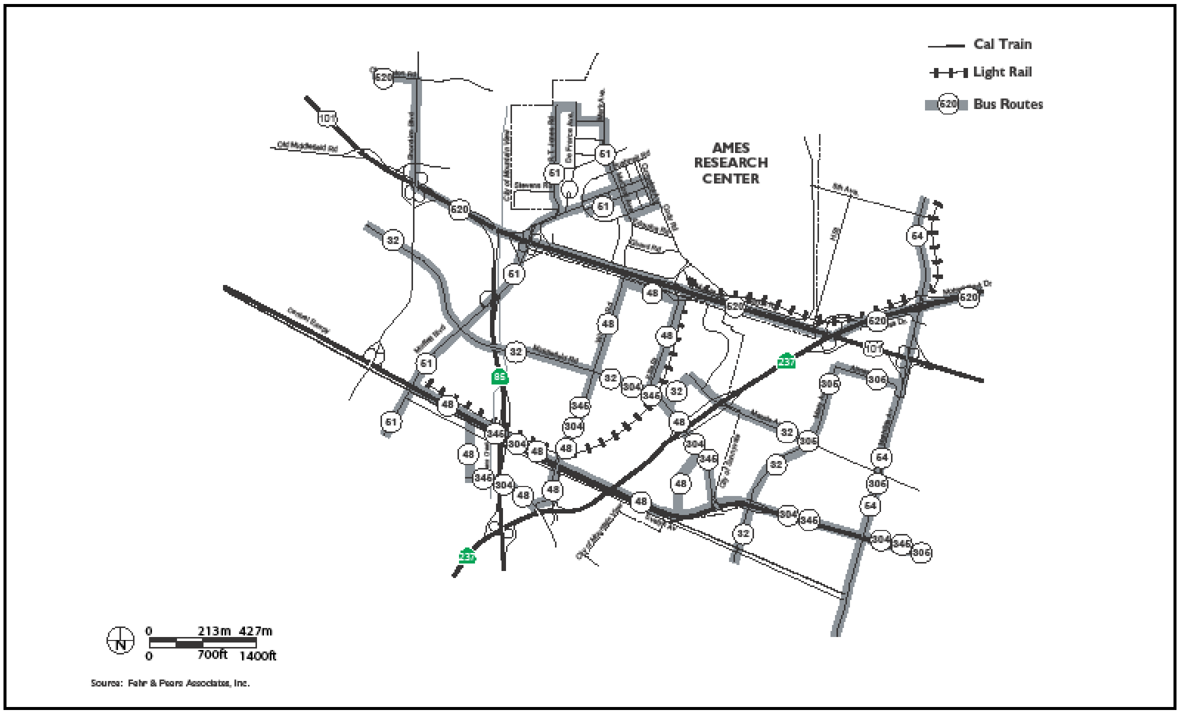

Figure 14-3 Existing Transit Service

Public transportation is available through the Santa Clara County Transit System and Caltrain. In addition, VTA has extended light rail service from Santa Theresa and San Jose to Mountain View. The new light rail line traverses the southern edge of ARC.

The primary transit service provider in the ARC area is VTA, which operates bus and light rail service throughout Santa Clara County.

Only one transit bus route (Route 51) provides direct service to ARC. Route 51 operates between Vallco Fashion Park in Cupertino and the ARC area, including service to downtown Mountain View. In the AM and PM peak periods, buses are routed through ARC. During off-peak periods and weekends, buses loop through the Orion Park Military Housing area without entering ARC. Service is provided at 30- to 60-minute headways on weekdays and at 60-minute headways on weekends. Additional express and fixed-route bus service is provided in the Moffett Park area in Sunnyvale (Routes 26, 54, 122, 321, 328, and 520) and on Ellis Street, Whisman Road, and Middlefield Road (Routes 32, 48, 304, 305, and 345) in Mountain View. However, these routes do not provide service close enough to the project site to generate substantial ridership.

The light rail connects ARC to downtown San Jose and downtown Mountain View, including the Mountain View Caltrain station. Trains run 24 hours a day at 10-minute headways during the peak periods and 20- to 60-minute headways during other periods.

Caltrain operates between Gilroy and San Francisco, with the nearest station located in downtown Mountain View. NASA currently operates a shuttle between ARC and the Mountain View Caltrain station.

According to VTA, approximately 150 persons board and depart the light rail trains at the NASA/Bayshore Station. Within ARC, 64 persons board and depart the Route 51 bus. In addition, approximately 100 people at ARC currently participate in NASA's transit pass subsidy program. Daily directional ridership on NASA's shuttle to Caltrain varies between 40 and 60, according to NASA staff. NASA’s shuttle also goes to the LRT station.

14.4.5. PARKING

Parking is currently accommodated at a number of lots and onstreet locations throughout ARC. An inventory conducted in February and March 1999 identified more than 10,000 parking stalls or spaces within the entire ARC complex. Parking lots in the existing interior portion of ARC are relatively small and scattered and tend to be centralized near highly populated buildings. Parking also occurs on the internal road system at the facility and on adjacent areas. Visitor parking for about 50 cars and one bus is provided next to the visitor center, along Moffett Boulevard next to Building 943.

Overall, a concentration of people working in certain areas has caused a demand for parking spaces that often exceeds supply. Overflow parking must be utilized in these areas. This results in parking congestion, particularly during periodic conferences. Although the parking situation is inconvenient at times, it does not constitute a serious environmental problem.

14.4.6. TRANSPORTATION DEMAND MANAGEMENT

NASA has a Commute Alternatives program that helps reduce the number of automobiles trips at ARC (Design, Community & Environment 2002). These programs include:

- Caltrain and Light Rail Shuttle - NASA operates a direct shuttle between ARC and the Caltrain station in downtown Mountain View. Directional ridership (the number coming into ARC in the morning or leaving in the afternoon) varies between 40 and 60 people per day, depending on the season. NASA also provides shuttle operations to serve the Bayshore light rail station near the Ellis Street/Manila Street intersection.
- Transit Pass Subsidies - All civil servants (NASA employees and military personnel) at ARC are eligible for reduced-cost transit passes ($30 off the monthly pass for any Bay Area transit service).
- Flexible Work Schedules - Under a NASA-wide policy, employees can work flexible schedules with the approval of their supervisor. Options include starting as early as 6:00 a.m., working a compressed schedule that allows for every second Monday or Friday off, or working four 10-hour days per week. Detailed information on the impact of this program is not available; however, informal inquiries revealed that many employees take advantage of this flexibility to avoid commuting during the worst of the peak hours.
- Telecommuting - Employees can arrange with their supervisor to telecommute.
- Bicycle Lockers - Bicycle lockers are provided at several locations throughout the ARC campus. These lockers are intended for employees who cycle to work at least 3 days per week. Currently, 94 people have registered for lockers. In addition, VTA recently installed six bicycle lockers at the Bayshore light rail station at employees' requests.
- "Community" Bicycles - A number of individual branches and divisions at ARC have purchased bicycles that may be used by their employees for travel within the campus. This program is not available to all employees, and influences only internal trip-making (Klim 2000).

14.5. ENVIRONMENTAL MEASURES

NASA and ARC have identified the following environmental measures that are designed to address potential transportation and traffic effects of operations and future development at ARC and are implemented to the extent feasible.

14.5.1. TRANSPORTATION DEMAND MANAGEMENT PROGRAM

NASA's existing Transportation Demand Management program results in an estimated 21% reduction in the number of single-occupant vehicle trips generated by the NASA-controlled portion of ARC relative to the typical number of single-occupant trips that would otherwise be expected from a similar number of employees in Santa Clara County. Additional opportunities for employees and visitors to use alternative modes of travel will be provided by the extension of the Tasman East VTA light rail line from Interstate 880 in Milpitas to Hostetter Road in San Jose (scheduled for fall 2004), as well as further expansion of ACE train service between the Central Valley and Santa Clara County, including accommodation of additional bicycles on each train and the expansion of BART to the San Jose area.

14.5.2. MITIGATION MEASURES

The NASA Ames Development Plan (NADP) Final Programmatic Environmental Impact Statement (FEIS) identified the mitigation measures to address potential transportation and traffic impacts from build out of Mitigated Alternative 5 in the NADP (Design, Community & Environment 2002). For a full discussion of impacts and mitigation measures related to the NADP, see the FEIS.

Table 14-5 Existing Freeway Operations (Near Site)

				Existing[1]				
	Segment	Direction	Peak Hour	Lanes	Volume	Average Speed	Density	LOS[2]
U.S. 101	North of Lawrence	NB	AM	3	4,675	60	27	D
U.S. 101	North of Lawrence	NB	PM	3	5,675	60	33	D
U.S. 101	Moffett to SR 85	NB	AM	3	3,960	15	88	F
U.S. 101	Moffett to SR 85	NB	PM	3	4,550	15	101	F
U.S. 101	Moffett to SR 85	SB	AM	3	6,900	50	46	D
U.S. 101	Moffett to SR 85	SB	PM	3	5,940	55	36	D
U.S. 101	Moffett to SR 85	NB HOV	AM	1	1,340	15	89	F
U.S. 101	Moffett to SR 85	NB HOV	PM	1	1,960	40	49	E
U.S. 101	Moffett to SR 85	SB HOV	AM	1	1,800	60	30	D
U.S. 101	Moffett to SR 85	SB HOV	PM	1	1,440	60	24	C
U.S. 101	SR 237 to Moffett	NB	AM	3	3,960	15	88	F
U.S. 101	SR 237 to Moffett	NB	PM	3	4,500	25	60	F
U.S. 101	SR 237 to Moffett	SB	AM	3	4,950	25	66	F
U.S. 101	SR 237 to Moffett	SB	PM	3	5,940	55	36	D
U.S. 101	SR 237 to Moffett	NB HOV	AM	1	1,440	20	72	F
U.S. 101	SR 237 to Moffett	NB HOV	PM	1	1,380	60	23	C
U.S. 101	SR 237 to Moffett	SB HOV	AM	1	1,620	60	27	D
U.S. 101	SR 237 to Moffett	SB HOV	PM	1	1,260	60	21	C
U.S. 101	Mathilda to SR 237	NB	AM	3	4,740	20	79	F
U.S. 101	Mathilda to SR 237	NB	PM	3	5,040	60	28	D
U.S. 101	Mathilda to SR 237	SB	AM	3	6,450	50	43	D
U.S. 101	Mathilda to SR 237	SB	PM	3	5,220	60	29	D
U.S. 101	Mathilda to SR 237	NB HOV	AM	1	1,790	35	51	E
U.S. 101	Mathilda to SR 237	NB HOV	PM	1	1,200	60	20	C
U.S. 101	Mathilda to SR 237	SB HOV	AM	1	1,680	60	28	D
U.S. 101	Mathilda to SR 237	SB HOV	PM	1	1,320	60	22	C
SR 85	Central Expwy. to U.S. 101	NB	AM	2	3,160	20	79	F
SR 85	Central Expwy. to	NB	PM	2	2,080	65	16	B

	Segment	Direction	Peak Hour	Existing[1]				
				Lanes	Volume	Average Speed	Density	LOS[2]
	U.S. 101							
SR 85	Central Expwy. to U.S. 101	SB	AM	2	1,560	65	12	B
SR 85	Central Expwy. to U.S. 101	SB	PM	2	3,450	25	69	F
SR 85	Central Expwy. to U.S. 101	NB HOV	AM	1	980	65	15	B
SR 85	Central Expwy. to U.S. 101	NB HOV	PM	1	520	65	8	A
SR 85	Central Expwy. to U.S. 101	SB HOV	AM	1	780	65	12	B
SR 85	Central Expwy. to U.S. 101	SB HOV	PM	1	780	65	12	B
SR 237	Maude to U.S. 101	WB	AM	2	3,120	60	26	D
SR 237	Maude to U.S. 101	WB	PM	2	4,290	55	39	D
SR 237	Maude to U.S. 101	EB	AM	2	3,250	25	65	F
SR 237	Maude to U.S. 101	EB	PM	2	1,690	65	13	B
SR 237	U.S. 101 to Mathilda	WB	AM	2	3,720	60	31	D
SR 237	U.S. 101 to Mathilda	WB	PM	2	4,180	55	38	D
SR 237	U.S. 101 to Mathilda	EB	AM	2	2,610	15	87	F
SR 237	U.S. 101 to Mathilda	EB	PM	2	2,760	60	23	C
SR 237	Mathilda to N. Fair Oaks	WB	AM	2	3,590	60	26	D
SR 237	Mathilda to N. Fair Oaks	WB	PM	2	4,430	55	35	D
SR 237	Mathilda to N. Fair Oaks	EB	AM	2	3,400	25	68	F
SR 237	Mathilda to N. Fair Oaks	EB	PM	2	2,400	60	20	C
SR 237	Mathilda to N. Fair Oaks	EB HOV	AM	1	1,620	60	27	D
SR 237	Mathilda to N. Fair Oaks	EB HOV	PM	1	650	65	10	A

Notes:
[1] Lanes, volume and density from VTA 2000 in Design, Community & Environment 2002.
[2] LOS based on speed presented in VTA 2000 in Design, Community & Environment 2002.

Table 14-6 Onsite Roadway Segment Traffic Volumes

Segment	Location	Direction	Daily	AM Peak	PM Peak	Sat.	Sun.
Gates							
Clark Memorial Drive	East of Main Gate	EB WB	8,376 8,987	856 211	227 901	7,194 6,022	5,283 5,244
Gate 17	East of R.T. Jones	EB WB	1,080 1,229	118 23	23 212		
Ellis Street	East of Manila	EB WB	2,523 2,256	294 93	76 157		
5th Avenue	West of Macon	EB WB	N/A N/A	34 18	30 43		
Onsite Roadways							
R.T. Jones Road	North of Clark Memorial	NB SB	5,782 4,717	225 245	290 343	3,507 3,404	2,600 2,521
Arnold Avenue	North of Clark Memorial	NB SB	4,103 1,266	684 0	52 229		
DeFrance Road	North of Bush Circle	NB SB	1,712 2,046	237 44	37 249		
Mark Road	North of Bushnell	NB SB	2,174 2,538	303 142	42 236		
King Road	East of DeFrance	EB WB	565 573	56 38	15 35		
Bushnell Road	East of Clark Memorial	EB WB	346 2,280	24 47	6 350		
North Akron Road South Akron Road	East of Clark Memorial	EB WB	3,152 4,073	108 463	312 187		
Westcoat Road	East of Clark Memorial	NB SB	2,256 513	154 21	137 45		
Girard Road	West of Cody	NB SB	205 157	19 19	16 11		
Edquiba Road	West of Cody	NB SB	1,536 1,404	52 63	103 131		
Cody Road	North of Edquiba	NB SB	2,152 2,055	215 99	121 192		
Macon Road	East and North of Ellis	NB SB	1,186 1,119	32 101	105 40		
	North of 5th Avenue	NB SB	977 977	81 29	35 72		
Source: NASA 1999 in Design, Community & Environment 2002.							

Chapter 15. Public Services, Utilities, and Energy

15.1. OVERVIEW

This chapter describes public and emergency services at ARC, including security and emergency services, schools, water supply, sanitary sewer service, solid waste and wastewater disposal, and energy supply. Stormwater management is discussed in Chapter 10, Hydrology and Water Quality.

Some information presented in Section 15.3, Existing Site Conditions, regarding fire, police, solid waste, and school services was obtained from the NASA Ames Development Plan Final Programmatic Environmental Impact Statement (Design, Community & Environment 2002).

15.2. REGULATORY REQUIREMENTS

The principal guidance for most public and utility services at ARC is embodied in Ames Management Directives (APR 1280). Energy consumption is regulated consistent with the National Energy Conservation Policy Act of 1978 (NECPA) and Executive Order 12759 (*Federal Energy Management*). The following sections provide additional information on regulatory requirements.

15.2.1. FEDERAL GUIDELINES FOR ENERGY CONSUMPTION

The NECPA and Executive Order 12759 required all federal agencies, including NASA, to implement specific energy resource management goals. These goals included reduction from fiscal year 1985 consumption, including a 10% reduction in energy consumption by fiscal year 1995 and a 20% reduction by fiscal year 2000.

Other goals outlined in NECPA and Executive Order 12759 include:

- Minimizing reliance on petroleum through development and use of alternative energy sources
- Procuring energy-efficient goods and products
- Participating in demand-side management services
- Using outreach programs to promote vehicle fuel efficiency
- Achieving a 10% reduction in fuel consumption in federal vehicles by 1995

15.3. EXISTING SITE CONDITIONS

15.3.1. SECURITY AND EMERGENCY SERVICES

15.3.1.1. Security

ARC, with exception of the NASA Research Park, is a closed federal facility. Public access to the campus is restricted. The site can be entered through several secured points. Visitors to the NRP are required to show a California driver's license at the main gate. Visitors to the Ames Campus or Eastside Airfield are required to enter through the visitor pass and identification facility (Building 26), where they must sign in and are issued a temporary identification badge. This badge and a picture ID are required to enter through the Ames Campus gates or the Eastside Airfield Gate. ARC employees and contractors are also required to wear identification badges with photographs. The campus is regularly patrolled by NASA Ames' armed security force.

15.3.1.2. Emergency Services

In case of an emergency, NASA's Emergency Control Center Duty Office performs dispatch services. The following sections describe the services available to respond to emergencies at ARC.

Disaster Assistance and Response Team

ARC's volunteer Disaster Assistance and Response Team (DART) are available to respond to catastrophic emergencies (for example, earthquakes or other center-wide emergencies).

Hazardous Materials Response

ARC has a 24-hour Emergency Spill Response Team responsible for cleanup of hazardous materials spills and releases. The Ames Fire Department, Ames Plant Engineering Branch, Ames Safety Office, and the Ames Environmental Office comprise this response team, which is activated by calls to 911 from any onsite telephone line.

Health Care

A health unit for ARC staff and other personnel on the site is located in Building N-215. The health unit is staffed by a physician and two nurses and offers first aid, emergency medical services, and referral services. Medical emergencies can also be handled by the Moffett Field Fire Department (MFFD), which has firefighters trained as emergency medical technicians. In addition, the Duty Office can call the Santa Clara County Paramedics, if necessary.

Police Protection

The NASA/ARC Protective Services Office, Security Services Branch, oversees Law enforcement at ARC under NASA's Federal Law Enforcement Authority pursuant to the Space Act (42 USC 2456 and 2456a). Currently, NASA contracts with a private company to provide police protection services.

Fire Protection

NASA provides fire protection services at ARC through contracted services. The fire department's personnel are housed in an onsite building. Most buildings at ARC are equipped with fire detection devices, some of which are connected to the central dispatch facility.

The MFFD is also available to provide fire protection services in an emergency. In addition, ARC participates in the Santa Clara County Fire Mutual Aid Service and has a cooperative response agreement with all the city fire departments in Santa Clara County. Because of its proximity to ARC, the Mountain View Fire Department would be the first department contacted if additional fire response was needed. If Mountain View could not respond, the CANG dispatcher would then contact the City of Sunnyvale Fire Department, which is the next closest to ARC. If Sunnyvale were also unable to respond, the CANG dispatcher would continue to contact Santa Clara city departments until assistance was found.

When a fire department acts under the Santa Clara County Fire Mutual Aid Agreement, the standard procedure is to provide two fire engines, one truck, and one chief officer. The maximum amount of support available to NASA for a serious emergency would be 22 fire engines with four firefighters each, seven trucks, and seven chief officers. The only situation where NASA would be without substantial backup support would be if another event or combination of events occurred that affected all cities in Santa Clara County (Gippietti personal communication in Design, Community & Environment 2002)

15.3.2. SCHOOLS

There is no permanent housing at ARC and therefore no demand for school services. Children who live in the Military Housing areas, which are located in portions of Moffett Field not under NASA control, attend elementary and middle schools in the Mountain View-Whisman School District and high schools in the Mountain View-Los Altos Union High School District. Table 15-1 shows current enrollments at the schools that serve the ARC community.

Table 15-1. Capacity and Enrollment at Schools near ARC

District/School	Enrollment	Capacity
Mountain View-Whisman School District		
Monte Loma Elementary School	479	479
Crittenden Middle School	514	514
Graham Middle School	731	743
Theuerkauf Elementary School	466	468
Landels Elementary School	498	511
Mountain View-Los Altos Union High School District		
Mountain View High School	1,449	1,400
Los Altos High School	1,379	1,500
Sources: Mountain View-Whisman School District and Mountain View-Los Altos High School District 2000, 2001 in Design, Community & Environment 2002.		

15.3.2.1. Mountain View-Whisman School District

The Mountain View-Whisman School District has 14 public schools. Children living in Moffett Field Military Housing attend Landels, Monte Loma, and Theuerkauf Elementary Schools and Graham and Crittenden Middle Schools. As of November 1999, approximately 221 students from the Military Housing areas were attending schools in the Mountain View School District. All schools within the Mountain View-Whisman School District are at slightly below capacity; as of fall 2001, there was capacity for 23 additional students at the five schools in the district that serve Moffett Field.

15.3.2.2. Mountain View-Los Altos Union High School District

Students from the Mountain View-Whisman School District feed into the Mountain View-Los Altos Union High School District. In 1998, 21 students from the Military Housing areas attended high schools in this district; 14 attended Mountain View High School and seven attended Los Altos High School. As of October 2001, total enrollment at Mountain View High School was 1,449 students, slightly over the school's capacity of 1,400 students. In 2001, total enrollment at Los Altos High School was 1,379, approximately 92% percent of the school's 1,500-student capacity

15.3.3. WATER SUPPLY

15.3.3.1. Overview of Existing System

ARC receives its potable water and fire protection supply from the San Francisco Water Department (SFWD). Approximately 85% of this water comes from SFWD's Hetch Hetchy System and about 15% from East Bay Municipal Utility District (EBMUD) sources. SFWD supply is chlorinated in Tracy but is otherwise untreated prior to its delivery to South Peninsula water users. At ARC, water that is used in steam boilers undergoes softening.

NASA contracts directly with SFWD for the purchase of water. The current annual water demand at ARC, which is roughly 901 megaliters (238 million gallons), is substantially less than demand when the base was fully occupied by Navy personnel. There is no formal allocation of water from SFWD to ARC.

NASA owns and operates the entire potable water system at ARC. The original freshwater distribution system was installed in 1932 using cast iron pipe ranging in diameter from 152 millimeters (6 inches) to 203 millimeters (8 inches). The overall condition of the old cast iron system is fair, and it typically requires only routine maintenance. However, a large portion of the system has deteriorated such that it must operate at reduced pressure to lessen the occurrence of leaks and other malfunctions. In addition, some sections have been repaired in recent years, and the most problematic water lines and gate valves have been replaced, some lines by asbestos-cement, ductile iron, or plastic pipe through progressive repairs.

The present distribution system consists of over 37,000 meters (120,000 linear feet) of water line. Although most of the system is well laid out and has adequate internal looping, the pipes are generally undersized and cannot provide sufficient flow to meet public fire protection criteria.

In January 2001, the San Francisco Public Utilities Commission (SFPUC), which is responsible for the Hetch Hetchy System, completed a regional system overview and reliability response study as part of its Facilities Reliability Program (Design, Community & Environment 2002). The study evaluated the reliability of the SFPUC water system in the event of a major earthquake on the San Andreas, Hayward, Calaveras, or Great Valley fault. The study estimated that SFPUC regional water supplies would be unavailable to most system customers around the Bay within hours of such an event, and that service might not be restored for 20-30 days or longer. Until SFPUC water service could be restored, most system customers, including ARC, would need to rely on local sources for firefighting, potable supply, and sanitation. Restoration of full service to meet average daily water demands would require an estimated 6 months, or longer if labor, materials, or equipment were difficult to obtain. Accordingly, SFPUC's report recommends that storage facilities be able to withstand seismic shock.

Generally accepted design practices call for storage to provide three days of domestic water use in addition to flow to fight the design fire. For ARC's current needs, this equates to roughly 11.4 million liters (3 million gallons) of storage. Existing storage is limited to 3.6 million liters (950,000 gallons), most of which is for the foam fire system used to protect Buildings N-211 and N-248.

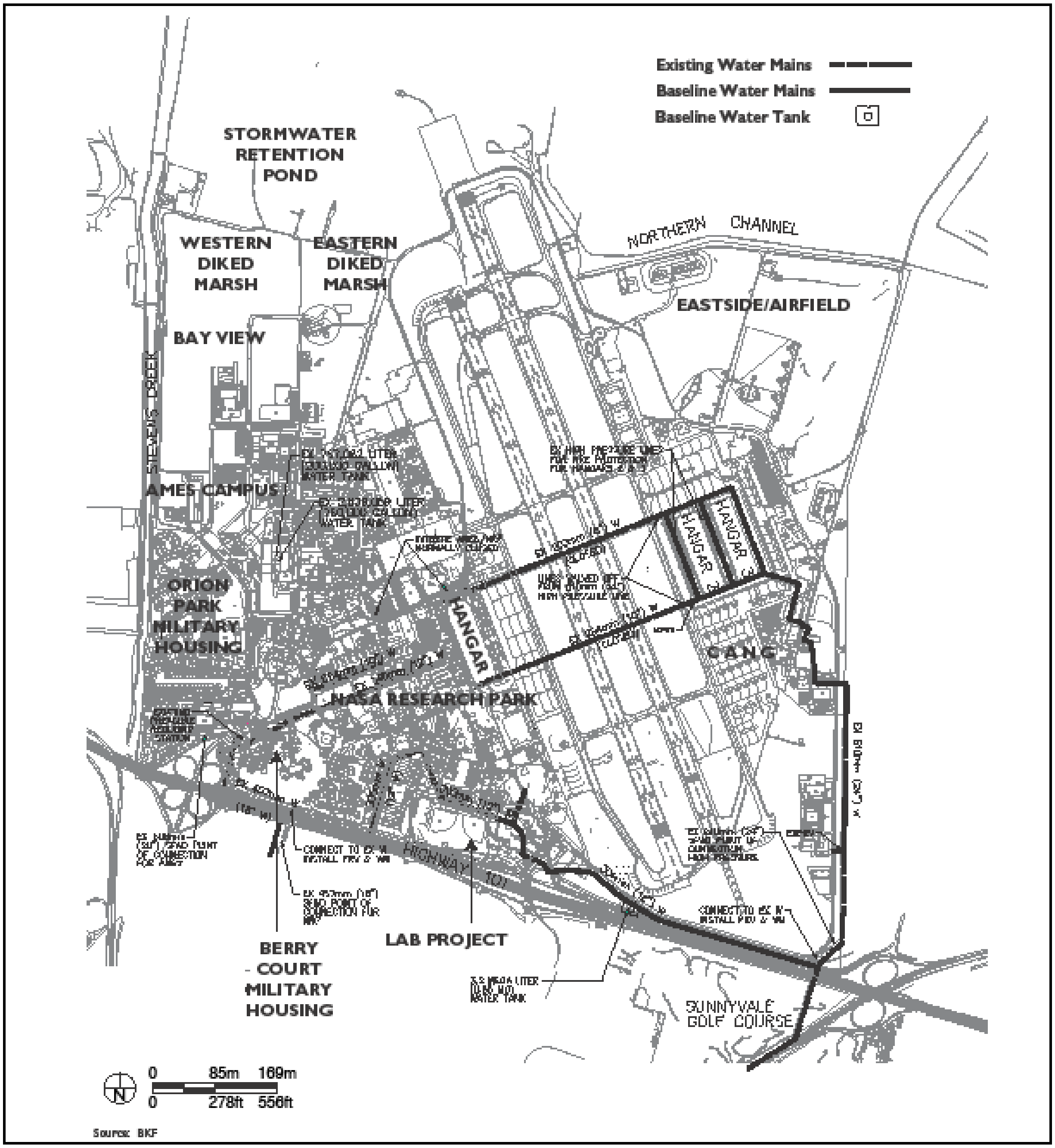

Figure 15-1 Baseline Conditions Water System

NRP Area

The primary water supply to ARC comes into the NRP area from an SFWD meter at Tyrella Street, where SFWD provides service to a 460-millimeter (18-inch) branch from a multiple-metered vault served by a 4600-millimeter (180-inch) aqueduct. Pressure is reduced from 830 kilopascals (kPa) (120 pounds per square inch [psi]) to 310 kPa (45 psi) at the main meter vault for distribution. Flow is then regulated through two 150-millimeter (6-inch) meters that have a maximum total capacity of 19,000 liters per minute (5,000 gallons per minute [gpm]). The water supply for the Berry Court housing area is also drawn from the NRP distribution system.

The water distribution system in the NRP area is in worse condition than that serving the other parts of ARC. To minimize leaks and localized failures in this part of the system, the operating pressure in this area has been reduced to 310 kPa (45 psi), requiring that inter-ties to other parts of the ARC campus be closed off, as discussed in more detail below. Nonetheless, ongoing maintenance and repair has kept the NRP system operational and has eliminated the most serious deficiencies. The main line that runs along South Akron Road was replaced with 300-millimeter (12-inch) ductile iron pipe (1999). A parallel line located in North Akron Road was also replaced with a 250 mm (10-inch) PVC pipe. This has increased the overall capacity of the system substantially, but the operating pressure is still limited by the weaker portion of the system.

The NRP water system is connected to both the Ames campus area and Eastside/Airfield water systems. The Ames campus water system connects to the NRP system via two 200-millimeter (8-inch) valves located along Bushnell Street at McCord and Cummins Avenues. To avoid damage to the NRP system because of the Ames campus system's higher operating pressure, the valves are normally closed. The Eastside/Airfield water system connects to the NRP system via two lines that cross under the runway. One line is 200 millimeters (8 inches) in diameter and the other is 250 millimeters (10 inches). The valves on these lines are located in the middle of the runway infield, and are normally kept closed because of the large difference in operating pressure between the two systems.

Fire flow is provided through the potable water distribution system. Hydrants are flushed annually and flow checks are performed every five years. Fire hydrants are also periodically used to irrigate landscaped areas. The fire capacity design for ARC is not based on the largest building size because the larger buildings have sprinkler systems. Instead, the ARC fire marshal has set the minimum fire capacity for new systems at 5,700 liters per minute (1,500 gpm) at 140 kPa (20 psi) residual as required by the Uniform Fire Code. The April 2000 fire hydrant report shows a range of flows, with many hydrants providing less than 3,800 liters per minute (1,000 gpm) and the lowest providing less than 2,300 liters per minute (600 gpm) (Design, Community & Environment 2002).

An unused 740,000-liter (200,000-gallon) elevated tank is located within the NRP area east of Shenandoah Plaza. The tank presently contains a small amount of stagnant water, and there is some concern that this water could leak into the main system and contaminate potable supply. The tank could not be brought back into service without being drained, cleaned, and seismically retrofitted. A pump station would also have to be installed adjacent to the tank both to fill the tank and to boost the pressure of water drawn from the tank to supply the distribution system. At present, there is no plan to restore the tank to service.

Ames Campus and Bay View Areas

A 510-millimeter (20-inch) asbestos cement pipe that runs parallel to the US-101 North onramp along Moffett Boulevard and provides an operating pressure of 410 - 450 kPa (60 - 65 psi) serves the Ames campus area. This main feed also serves the Orion Park Military Housing, and there are several inter-ties between the two areas.

Fire flow is provided through the potable water distribution system, with a hydrant maintenance program similar to that employed in the NRP area. The fire protection capacity of the Ames campus system is greater than that of the NRP system because of the better condition of the pipes, which enables higher operating pressures. The Ames campus system is fed from a single source with no open connections to the NRP area or the Eastside/Airfield loop. The Ames campus water system is connected to the NRP system by two 200-millimeter (8-inch) valves that are normally closed to protect the NRP system. These closed valves limit the redundancy of the fire protection system.

Two storage tanks located near the ARC wind tunnels have a combined capacity of approximately 3.6 megaliters (950,000 gallons). The larger tank (2.8 megaliters or 750,000 gallons) is situated at grade and provides water for the foam fire protection system that protects Buildings N-211 and N-248. The smaller tank (0.8 mega-liters or 200,000 gallons) is elevated and is kept partially filled because of seismic safety concerns.

Eastside/Airfield Area

The Eastside/Airfield area is served by a 610-millimeter (24-inch) feed from SFWD's 4,600-millimeter (130-inch) aqueduct near the intersection of US-101 and SR-237. The feed enters ARC east of the runway and runs parallel to Macon Road. The pressure in the feed is maintained at the aqueduct's 830-kPa (120-psi) operating pressure, and there are no pressure-reducing stations in the main loop within the Eastside/Airfield area. Substantially higher water pressure is required in this area to support fire protection at Hangars 2 and 3 east of the runways, where a minimum fire flow of 38,000 liters per minute (10,000 gpm) is needed.

The Eastside/Airfield distribution system contains lines ranging from 200 millimeters (8 inches) to 250 millimeters (10 inches) in diameter with several smaller-diameter dead ends. The only significant looping in this system is found surrounding the hangars. The Eastside/Airfield water system is connected to the NRP system via one 200-millimeter (8-inch) line and one 250-millimeter(10-inch) line, as discussed above.

There is no water storage within the Eastside/Airfield area.

15.3.4. RECLAIMED WATER

Four potential sources of reclaimed water are available at ARC: the Navy source, the Middlefield-Ellis-Whisman (MEW)/NASA source, an existing City of Sunnyvale source, and a potential City of Mountain View source. The Navy and MEW/NASA collect and treat groundwater onsite as part of ongoing environmental remediation programs. Additional water reclamation programs are in place or planned by the Cities of Mountain View and Sunnyvale. Treated groundwater and industrial wastewater undergoes additional treatment for in NASA's recently constructed Industrial Wastewater Treatment Facility N-271 for reuse at ARC. The following sections provide additional information on reclaimed water. Figure 15-2 shows the reclaimed water system infrastructure. The NASA Exchange golf course has been retrofitted to include reclaimed water for irrigation.

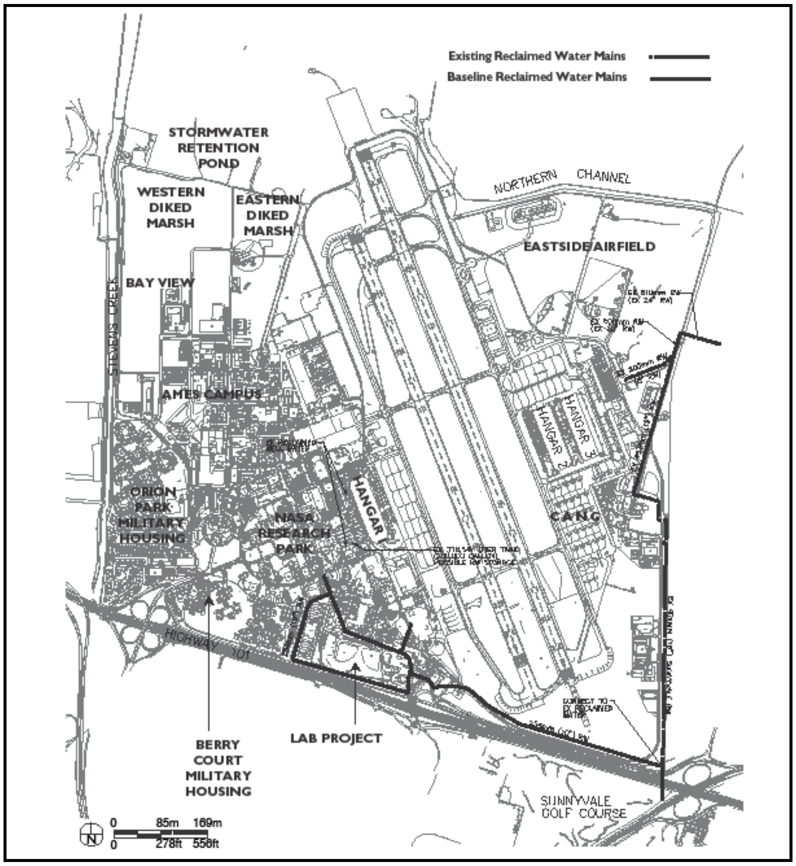

Figure 15-2 Baseline Conditions Reclaimed Water System

15.3.4.1. Navy Treated Groundwater

The Navy treats groundwater on site as part of an ongoing environmental remediation program. It is extracted from aquifers that are contaminated with trichloroethylene, perchloroethylene, and fuel (see additional discussion in Chapter 10, Hydrology and Water Quality and Chapter 17, Hazardous Materials). The treated water meets current NPDS discharge standards. NASA would like to use this water for irrigation in the NRP area to reduce demand for potable supply.

15.3.4.2. Middlefield-Ellis-Whisman Reclaimed Water

The MEW companies are conducting groundwater remediation under EPA supervision. The MEW reclaimed water is collected and treated on site as part of an ongoing environmental remediation program. It is collected from the same aquifer as the Navy reclaimed water but from a separate allocated area, the MEW treatment area is primarily contaminated with trichloroethylene and perchloroethylene (see additional discussion in Chapter 10, Hydrology and Water Quality and Chapter 17, Hazardous Materials). The treated water meets current NPDES discharge standards. NASA further treats some of this water at N-271 and then reuses it in wind tunnel cooling towers and the ARC jet boiler to reduce demand for potable supply.

15.3.4.3. Sunnyvale Reclaimed Water

The Eastside/Airfield area is currently served by a 610-millimeter (24-inch) feed from the City of Sunnyvale's reclaimed water system, which enters ARC at the Lockheed Gate north of First Avenue. The line "Ts" and is reduced to 510 millimeters (20 inches) to continue south along East Patrol Road. The main line is reduced again to 460 millimeters (18 inches) where a 200-millimeter (8-inch) service line Ts off toward the Airfield Substation (Building 591). The main line is further reduced to 410 millimeters (16 inches) as it parallels Macon Road. The line leaves ARC at the southeast corner of the site, near the intersection of US-101 and SR-237.

The City of Sunnyvale has indicated that there may be adequate supply available to serve all of ARC with reclaimed water. This water is suitable for use as irrigation water, and is used for irrigation at the Moffett Field Golf Course.

15.3.4.4. Mountain View Reclaimed Water

The City of Mountain View does not have reclaimed water available at ARC at this time. However, Mountain View is encouraging the use of reclaimed water for new projects within its service area and has joined with the Palo Alto Regional Water Quality Control Plant to apply for federal funding to construct a reclaimed water line between the treatment plant and ARC. This source could be available to serve future phases of development at ARC.

15.3.4.5. Treatment of Reclaimed Water for Industrial Use

NASA has recently constructed an Industrial Wastewater Treatment Facility (IWWTF) to remove metals and dissolved solids from industrial wastewater and treated groundwater. Effluent from the IWWTF is used as makeup water in the boiler for the Arc Jet Facility and in the Unitary Plan Wind Tunnel cooling tower. The new IWWTF provides 38.2 million liters (10.1 million gallons) of makeup water per year to the Arc Jet boiler, which will reduce by that amount demand for SFWD potable water and the volume of water discharged to the Palo Alto Regional Water Quality Control Plant. The Unitary Plan Wind Tunnel cooling tower is emptied three times per year. This represents another 3.8 million liters (1 million gallons) per year that will be treated in the IWWTF and reused in the cooling tower, which will further reduce demand for SFWD potable supply and discharge to the Palo Alto Regional Water Quality Control Plant.

The IWWTF provides an additional 12.5 million liters (3.3 million gallons) per year of makeup water to the Unitary Plan Wind Tunnel cooling tower by supplying groundwater from MEW and NASA extraction wells that has undergone additional treatment to remove dissolved solids. Treatment and reuse of this water will further lessen the demand for SFWD potable supply and reduce releases to Stevens Creek.

In summary, the IWWTF decreases the use of SFWD potable supply by a total of 14.4 million gallons per year, decreases discharges of industrial wastewater to the Palo Alto Regional Water Quality Control Plant by 11.1 million gallons per year, and decreases releases to Stevens Creek by 3.3 million gallons per year.

15.3.5. SANITARY SEWER SERVICE

Installation of the sewer system at what is now ARC began in the 1930s, and the oldest portions of the existing system date from this period. The majority of the pipe is vitrified clay and is in need of either rehabilitation or replacement.

ARC's sanitary sewer infrastructure includes approximately 27,700 meters (90,900 linear feet) of collection lines in two separate systems. One system serves the NRP area, including Shenandoah Plaza; the Eastside/Airfield area; the CANG area; and the southern and eastern portions of the Ames campus and Berry Court Military Housing. This system discharges into the City of Sunnyvale sewer system and is referred to as the eastern sanitary sewer system. The other system serves the Orion Park Military Housing, the remainder of the Ames campus, and the Bay View area. This system discharges into the City of Mountain View sewer system and is referred to as the western sanitary sewer system. The following sections provide additional detail on the eastern and western sanitary sewer systems.

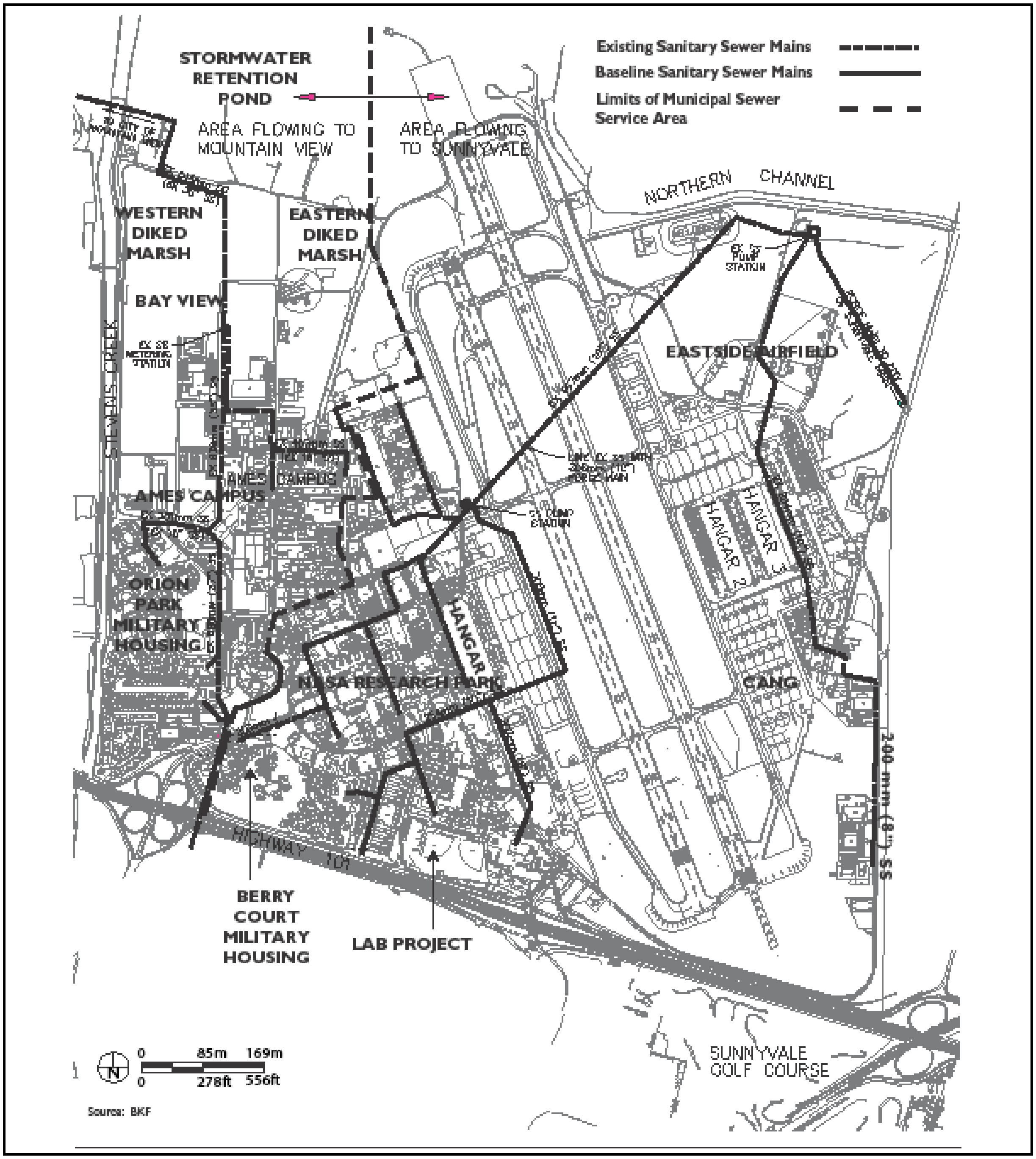

Figure 15-3 Baseline Conditions Sanitary Sewer System

15.3.5.1. Eastern Sanitary Sewer System

The eastern sanitary sewer system's main trunk line extends from the southwestern portion of the NRP area to the northeast portion of the Eastside/Airfield area. Collector lines from NRP, Berry Court Military Housing, Shenandoah Plaza, and the southern and eastern portions of the Ames campus feed into this trunk line. The Eastside/Airfield and CANG areas discharge directly into the existing pump station.

From Berry Court Military Housing and NRP, three main lines flow north through Shenandoah Plaza toward the main trunk line. Several smaller lines flow south and east toward the main trunk line from the southern and eastern portion of the Ames campus.

The main trunk line flows northeast beneath the existing airfield. It has a diameter of 460 millimeters (18 inches) and a capacity of 7,600 liters per minute (2,000 gpm). Currently, the peak wet-weather flow through this line is estimated at 4,160 liters per minute (1,100 gpm). Video logging of the sewer pipe conducted in 1995 showed that the line was in good condition at that time. Two manholes within the runway infield contain 300-millimeter (12-inch) storm drain lines. These lines are sound, and the potential for cross- contamination appears to be minimal.

From the airfield, the main sewer line continues northeast to a pump station located in the northeastern portion of the Eastside/Airfield area. Although still functional, the pump station is nearing the end of its useful life and will eventually be replaced rather than refurbished because its design is outdated. The pump station has a capacity of 7,600 liters per minute (2,000 gpm), and receives a peak wet-weather flow of approximately 4,900 liters per minute (1,320 gpm). From the pump station, sewage is conveyed east through a 250-millimeter (10-inch) force main to an offsite gravity main that continues on to the Sunnyvale Water Pollution Control Plant (SWPCP), located about 3 kilometers (2 miles) east of the ARC campus. The force main and gravity line that convey effluent from the pump station to the SWPCP are reported to be in good condition (Design, Community & Environment 2002).

The SWPCP has the capacity to treat 112 megaliters per day (29.5 million gallons per day [MGD]). It currently receives about 62.5 megaliters (16.5 MGD), and the City of Sunnyvale has no plans to expand it.

NASA's contract with the SWPCP is based on effluent content. ARC is classified as a metal finisher and is subject to local and federal regulations that limit the discharge of heavy metals. To ensure that applicable discharge standards are met, SWPCP takes monthly samples at six sewer system manholes within the ARC campus to monitor effluent content. Samples are tested for pH and heavy metals, including cadmium, chromium, lead, arsenic, and selenium.

15.3.5.2. Western Sanitary Sewer System

The western sanitary sewer system's main trunk line enters ARC immediately east of the Moffett Boulevard interchange as a 690-millimeter (27-inch) line running under US-101. The line extends from the freeway through ARC to a location north of the North Perimeter Road, where it leaves the site. This gravity line is operated by the City of Mountain View and is referred to as the East Trunk in their documents. The Mountain

View East Trunk originally served a large industrial complex south of US-101, which discharged a large volume of sewage. Since then, recent high-tech development has replaced the large industrial sites, and sewage flow at the point where the line enters ARC has decreased.

The East Trunk collects wastewater from an area south of US-101 before entering ARC, where it receives unmetered domestic flow from Orion Park Military Housing and metered industrial flow from the Ames campus area. Ames campus flow enters the line at a metering station north of Building N-255. The collection system within the Ames campus consists of lines with diameters ranging from 200 millimeters (8 inches) to 460 millimeters (18 inches). The metering station discharges to a 760-millimeter (30-inch) main, which in turn transitions to a 910-millimeter (36-inch) main as the line continues north and connects to the City of Mountain View sanitary sewer system.

The East Trunk flows to a lift station located near the Mountain View Golf Course. The lift station is already at its design capacity of 40 megaliters per day (10 MGD), and wet-weather flows exceed the station capacity two or three times a year. When that occurs, the Supervisory Control and Data Acquisition (SCADA) sensing system automatically shuts down the pumps and closes a slide gate in the lift station. This is referred to as *bypass mode*. Under bypass mode operations, sewage flows by gravity to the Palo Alto Regional Water Quality Control Plant. The City of Mountain View is required to notify ARC when this occurs, because flow can back up into the East Trunk line at least as far as the metering station. The City prepared a study of the lift station that recommended continuing to utilize bypass mode and expanding the downstream pipe rather than expanding the station's capacity (Design, Community & Environment 2002).

The Mountain View sewer system conveys flow to the Palo Alto Regional Water Quality Control Plant, which is jointly owned by the Cities of Palo Alto, Mountain View, and Los Altos and is operated by the City of Palo Alto. Mountain View currently has approximately 38% ownership and is entitled to 38% of the plant's capacity of approximately 144 megaliters per day (38 MGD) of dry-weather flow and 303 megaliters per day (80 MGD) of peak wet-weather flow. Current peak wet-weather flow into the plant is 227 megaliters per day (60 MGD). Mountain View's allocation of plant capacity is thus 55 megaliters per day (14.4 MGD) dry-weather flow and 114 megaliters per day (30 MGD) peak wet-weather flow, of which it currently uses approximately 37 megaliters per day (9.8 MGD) dry-weather flow and 83 megaliters per day (22 MGD) peak wet-weather flow.

Since 1993, ARC has had a separate permit with the Palo Alto Regional Water Quality Control Plant that provides for treatment of up to 1.14 megaliters per day (0.3 MGD) peak flow. Current dry-weather flow is approximately 0.8 megaliters per day (0.2 MGD). Wet-weather flow readings are unreliable, indicating a much higher peak flow than actually occurs, because the flow meter is inundated during large rainfall events; however, existing wet-weather flow is probably almost 2.3 megaliters per day (0.6

MGD). The existing wet- and dry-weather flows are higher than those predicted by Mountain View's current Sanitary Sewer Master Plan (City of Mountain View 1991).

15.3.6. SOLID WASTE DISPOSAL

NASA contracts for solid waste disposal and recycling at ARC. ARC has no active landfill, so solid waste is taken to the Newby Island Landfill in Milpitas. Newby Island receives an average of 817,000 tonnes (900,000 tons) of waste per year. It has a remaining capacity of 12 million cubic meters (16 million cubic yards) and is expected to reach capacity in 2020 (Cheso personal communication in Design, Community & Environment 2002).

In 2001, approximately 5,171 tonnes (5,700 tons) of solid waste were generated at ARC (Plant Engineering Branch 2001). As discussed in Chapter 19, Sustainability, recycling and composting programs have been implemented at ARC with the goal of reducing offsite waste disposal at landfills by 50%. In 2001, approximately 3,269 tonnes (3,604 tons) of the total solid waste generated at ARC were recycled on- or offsite, including 2,385 tonnes (2,629 tons) of green waste composted onsite. The remaining 884 tonnes (975 tons) of material included paper, cardboard, construction and demolition waste, scrap metal, tires, toner cartridges, and computers, all of which were recycled offsite. In March 2002, ARC submitted a Pollution Prevention Plan to NASA Headquarters that included a commitment to achieving the agency goal of a 35% diversion rate by 2010. Based on the data collected in 2001, ARC has already surpassed this goal; the 2001 data reflect a 63% diversion rate (Shelander personal communication in Design, Community & Environment 2002).

15.3.7. ENERGY

15.3.7.1. Electrical Service

NASA buys electrical power to serve ARC from two sources, the U.S. Department of Energy's Western Area Power Administration (WAPA) and the Pacific Gas and Electric Company (PG&E).

WAPA is contracted to provide NASA with firm power up to 80 megawatts (MW), which represents approximately 80% of the energy consumed at ARC. If this demand is exceeded, NASA buys the balance from PG&E, up to a maximum combined peak demand of 240 MW. NASA's agreement with PG&E is based on a real-time pricing rate schedule; the real-time price of power varies every hour as a function of overall system demand, which allows NASA to control its energy costs by scheduling high-demand testing during non-peak periods when electricity is less costly. Because of this arrangement, NASA is able to obtain power below the commercial rate for electricity.

Energy usage by resident agencies at ARC is managed by the RAs without NASA oversight. Since most of the RAs are federal agencies, however, they abide by the same energy regulations as NASA.

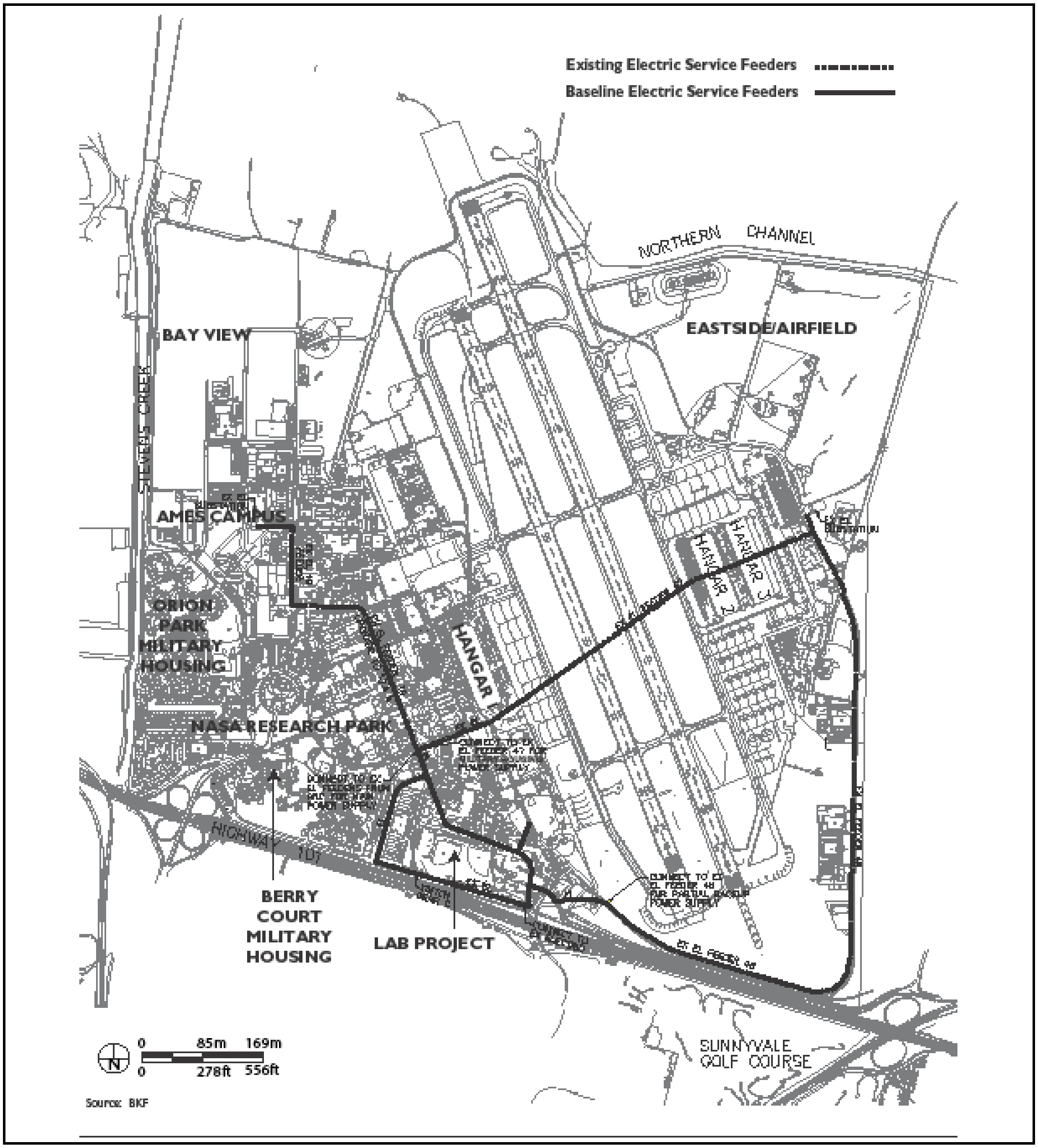

Figure 15-4 Baseline Conditions Electric System

Overview of the Existing System

The ARC substation was constructed in the 1940s and is centrally located in the Ames campus area. It receives power from two PG&E 115kV overhead transmission lines terminating at bus structures A and B that are dedicated exclusively to ARC. The bus structures serve as the main distribution point to 17 outdoor transformers that step down from 115kV to various secondary voltages (13.8kV to ARC, 12kV to the NRP area, and 6.9kV and other special voltages specific to lab testing). The 17 outdoor substation-type transformers have a total rating capacity of approximately 650 megavolt amperes (MVA). Of this total, substation-type transformers, dedicated to serve specific lab buildings and their large motor loads, provide 600 MVA (92%). The remaining 50 MVA provides typical electrical service for lighting, HVAC, and other such functions at buildings throughout the Ames campus. In addition to serving the Ames campus, the ARC substation provides emergency backup 12kV power to the switchgear located in the NRP area (Switchgear C) via Feeder 19, which has an estimated capacity of 6.5 MVA and runs through Shenandoah Plaza along McCord Avenue.

NASA's contract with WAPA limits the maximum rate of delivery to the ARC substation to 80 MW at a power factor of $\geq$0.95. Full utilization of the existing buildings served by the ARC substation would create a demand of nearly 36 MW for general (non-lab) applications. However, reduced occupancy and the implementation of energy conservation measures have dropped the demand to about 20 MW.

A second electrical substation was constructed in the early 1980s and is located in the Eastside/Airfield area, northeast of the hangars. The Airfield substation receives power from a single PG&E 115kV overhead transmission line that also provides power to the Lockheed property to the east. This 115kV line terminates at a 115-12kV substation at a dead-end structure and one 115kV oil circuit breaker that serves two step-down transformers, each rated at 7.5/9.9 MVA. The secondary sides (12kV) of both transformers terminate at a main breaker rated at 15kV, 500 MVA, 1200 amperes. The two mains, one tie, and seven feeder breakers are housed in an outdoor walk-in enclosure designated Switchgear A. The total transformer capacity is approximately 20 MVA.

This substation was originally dedicated to serve the Naval Air Station, which included the airfield; the NRP area, including the Shenandoah Plaza Historic District; and Military Housing to the south and west of ARC. At present, in addition to serving the Eastside/Airfield area, this substation provides power to Switchgear C through Feeder 47 (estimated capacity 6.7 MVA), which crosses the runways near the hangars, and Feeder 48 (estimated capacity 5.2 MVA), which runs south from the substation along Macon Road, around the southern end of the runways, and west to Switchgear C. If maintenance is necessary on any of the 115kV equipment, power must be cut to all facilities served by this substation.

NASA's contract with WAPA limits the maximum rate of delivery to the Eastside/Airfield substation to 5,009 kW at a power factor of 1.0, which translates to 5.01 MVA. Full utilization of the existing buildings served by the Airfield substation could create a demand of as much as 5 MW. Existing demand is about 3.5 MW.

NRP Area

Three major 12-kV incoming feeders serve Switchgear C, which is located in the NRP area at the northwest corner of the intersection of Bailey Road and South Perimeter Road. Switchgear C was installed in the mid-1980s and is in relatively good condition. Due to the feeder sizes, operation requires both Feeders 47 and 48 to be energized at Switchgear C in order to provide 11.2 MVA of load capacity. Feeder 19 is a backup and can only provide power to Switchgear C if the other two feeders' circuit breakers are locked out and in the open position.

The existing underground electrical distribution system in the NRP area consists of a mixture of terra cotta conduits (maximum size 89 millimeters or 3.5 inches), transite conduits, and PVC conduits (maximum size 127 millimeters or 5 inches, with the majority at 100 millimeters or 4 inches). Most new construction uses PVC conduits. Upgrading to a larger cable size in existing conduits is limited to the existing diameter size of the conduit. From a safety standpoint, many of the manholes are overcrowded with cables and are too small to accommodate the existing cabling system. In addition, the 12-kV system is incompatible with the 13.8-kV system in ARC, discussed below. In general, performing any maintenance on the distribution feeders in the NRP area interrupts service to many buildings because the existing distribution feeders are radial-feed.

Switchgear C provides power to the Military Housing areas, the runway lighting, and an antiquated low-voltage system that serves about 25 buildings in the NRP area. Voltage for this system is stepped down from 12 to 2.4kV at Switchgear E, located at the corner of Wescoat Road and McCord Avenue. Most of the transformers, switchgears, cables, and related components that make up the 2.4-kV system are reaching or have exceeded their life expectancy. Many of the 2.4-kV system feeders incorporate paper-insulated lead cables; lead is considered a hazardous material and must be handled and disposed in accordance with EPA regulations. In some cases, oil fuse cutouts or switches and cable-link boxes are still in service; these are also considered a safety hazard by today's standards. It had long been the intention of the Navy and NASA to phase out the 2.4-kV system. In 1992, NASA completed a construction project that installed eleven 15-kV pad-mounted distribution switches throughout the site. These distribution switches will be the points of connection for the existing building transformers when the 2.4-kV system is upgraded.

Ames Campus and Bay View Areas

The distribution system for the Ames campus area operates at 13.8kV and 7.2kV, and consists of an underground duct-bank system made up of cables, conduits, and manhole vaults. More than 100 distribution-type transformers located in or near buildings step the distribution voltage down to utilization level (480/277 V, 208/120 V). Distribution transformers include oil and dry types.

The ARC substation equipment and distribution system is more than 40 years old; the typical service life for medium- and high-voltage equipment is 20-30 years, and the cost to maintain this system will increase steadily as the system ages. The Electric Power Office was formed in the late 1990s in order to improve safety and prevent catastrophic failures of aging electrical infrastructure. Recent improvements to the system include replacing antiquated 115-kV oil circuit breakers, replacing transformer T-44 and repairing transformers T-45 and T-46, and replacing the power monitoring system. In addition, a program of maintenance and regularly scheduled replacement has been instituted for the protective relays on high- and medium-voltage systems. As of 2004, almost all of the 115-kV protective relays have been replaced with modern microprocessor components, with the remainder of the systems slated for replacement as needed. Additional planned improvements include replacing the recently retrofitted 15-kV-class air circuit breakers (SF6); 70% of the remaining lead cable; all building service transformers, primary switchgear, and secondary switchboards; and all underground distribution switches in manholes with aboveground distribution switches. The 7.2-kV distribution system will also be converted to 13.8kV. Once these improvements are complete, the only major remaining deficiency in the ARC campus area will be the underground duct-bank system, which is undersized and in poor condition.

A new dedicated 3 MW line for the N-258 has been installed, along with stand by generators.

Eastside/Airfield

The distribution system for the Eastside/Airfield area operates primarily at 12kV, with some remaining 2.4-kV portions. Switchgears B and D are located on Feeder 47 near the hangars and provide power to the buildings in this area. A 12-kV distribution system extends south, eventually running parallel to Feeder 48 along Macon Road, and provides power to the CANG facilities.

15.3.7.2. Natural Gas, Fuel Oil, and Propane

Space heating at ARC relies on natural gas. Fuel oil was used in the past, but all fuel tanks for space heating boilers were removed in the 1980s to reduce potential sources of subsurface contamination. Propane was used until the late 1980s but is no longer in use; the onsite propane facility was deactivated in 1990.

Overview of the Existing Natural Gas System

Natural gas supply for ARC is purchased directly from the producers through the Defense Energy Support Center (DESC). NASA pays PG&E a transmission fee to convey natural gas from the producers to the ARC campus via PG&E infrastructure. The main PG&E piping is considered a high-pressure natural gas piping system.

Natural gas is delivered to ARC via two main service lines (Figure 15-5).

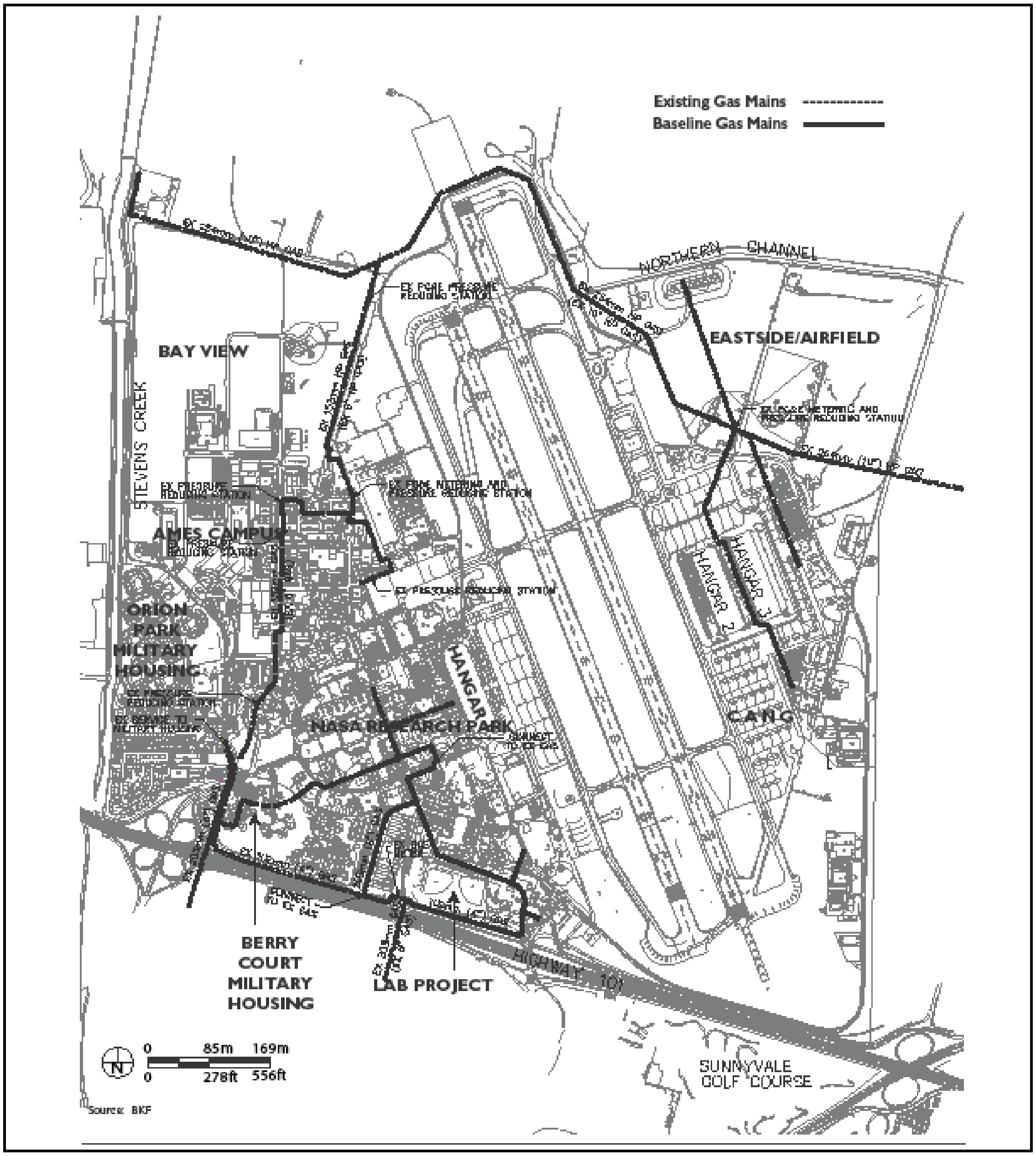

Figure 15-5 Baseline Conditions Gas System

The first is a 250-millimeter (10-inch) high-pressure 2,070 kPa (300 psig) east-west line that enters ARC north of the Bay View area and branches off to a 150-millimeter (6-inch) 97- kPa (140-psig) north-south line. (Note: psig is an abbreviation for pounds per square inch gauge, which describes the diameter of the pipeline.) The 250-millimeter (10-inch) line extends east around the north portion of the Eastside/Airfield area, through the golf course, and off the site. The capacity of this line is roughly 552,000 cubic meters per hour (19.5 million cubic feet per hour), provided that adequate supply is available. The north-south line extends south to a PG&E pressure-reducing station near the intersection of Lindbergh Avenue and North Perimeter Road, where pressure is lowered from 2,070 kPa (300 psig) to 970 kPa (140 psig). The line then continues south through the Bay View area to another PG&E pressure-reducing and metering station in the Ames campus area. From the Ames campus area, the line extends through the Berry Court Military Housing area, exiting ARC under US-101.

A second service line enters ARC via a separate crossing under US-101. The metering station (G-27) for this service is located at the northwest corner of Bailey Road and South Perimeter Road, and it serves the NRP area and Berry Court Military Housing.

A third line crosses under US-101 and onto Front Street. It serves Orion Park Military Housing, which is not part of ARC.

The following sections provide additional detail on natural gas service in each of the four planning areas.

NRP Area

The natural gas distribution system in the NRP area is considered a medium-pressure system. The NRP area receives natural gas supply through a 100-millimeter (4-inch) steel pipe that has a capacity of roughly 150,000 cubic meters per hour (5.3 million cubic feet per hour), provided that adequate supply is available. The incoming nominal pressure to the metering station at Bailey Road and South Perimeter Road is 450 kPa (65 psig), which is reduced to a nominal pressure of 117 kPa (17 psig) at the downstream portion of the metering station. From the metering station, natural gas is supplied to various buildings via a network of distribution pipelines.

The NRP area's natural gas distribution system appears to be in fair condition. Some of the existing steel pipes, primarily in the area west of Bailey Road, have been replaced with polyethylene pipes due to corrosion and gas leakage problems. Pipe corrosion resulted from the effects of a shallow water table on aging pipes. Gas valves found to be inoperable also posed a leakage hazard and have been replaced. Other valves are planned for replacement in the future.

The main natural gas meters in the NRP area appear to be in good condition. Some buildings in the area have sub-meters, which also appear to be in good condition. Other buildings have pressure regulators without gas meters on the supply piping.

The primary use of natural gas in the NRP area is for space heating in offices, lodging shops, and training centers. Additional gas consumers include cooking equipment, water heaters, and a boiler plant, which provides heat to most of the Shenandoah Plaza buildings.

Ames Campus and Bay View Areas

The Ames campus and Bay View areas receive natural gas through a 200-millimeter (8-inch) steel pipe, which is reduced to 150-millimeter (6-inch) and 100-millimeter (4-inch) steel piping loops elsewhere in the area.

The Ames campus/Bay View natural gas distribution system is considered a medium-pressure system. As described above, PG&E has a pressure-reducing station near the intersection of Lindbergh Avenue and North Perimeter Road, where the nominal pressure is reduced from the 2,070 kPa (300 psig) carried by the main line to 970 kPa (140 psig). The main pressure-reducing station in this area, located at the intersection of Mark Avenue and Hunsaker Avenue, reduces the nominal pressure from 970 kPa (140 psig) to 410 kPa (60 psig) and then to 140 kPa (20 psig) at the downstream portion of the metering station. Several other stations regulate the pressure down further to operating pressures in the range of 48-100 kPa (7-15 psig).

The natural gas distribution system in the Ames campus and Bay View areas appear to be in fair condition. Ongoing maintenance has kept the system in good working order. Some of the existing steel pipes have been replaced with polyethylene pipes because of corrosion and gas leakage. Gas valves have been removed and replaced, and some pipes have been abandoned and rerouted.

In the Ames campus and Bay View areas, natural gas is primarily used to heat offices and research facilities and to power domestic water heaters. It also powers a boiler plant in one of the research facilities.

Eastside/Airfield Area

The Eastside/Airfield area receives natural gas through PG&E's 250-millimeter (10-inch) trunk line, which crosses beneath the north end of the airfield. As discussed above, the pressure in the main line is 2,070 kPa (300 psig). A branch line with a capacity of about 221,000 cubic meters (7.8 million cubic feet) per hour extends from the main line to a pressure-reducing station where the pressure is reduced to 970 kPa (140 psig). After metering, the pressure is further reduced from 410 kPa (60 psig) at the downstream portion of the station. Several other pressure-reducing stations regulate the pressure down further to operating pressures in the range of 48-100 kPa) 7-15 psig).

The primary use of natural gas in the Eastside/Airfield area is space heating and domestic hot water.

15.3.7.3. Alternative Energy Sources

NASA has considered using solar water heating, buying energy from renewable energy sources, and buying electric vehicles. However, in part because of cost considerations, none of these options is considered feasible at this time. Electric carts have been extensively utilized on site.

ARC currently has no operating renewable energy systems except for N-245. Building N-245 has solar photovoltaic cells on the roof to augment purchased power.

15.4. ENVIRONMENTAL MEASURES

NASA and ARC have identified the following environmental measures that are designed to address potential air quality effects of operations and future development at ARC and are implemented to the extent feasible.

15.4.1. MEASURES TO MINIMIZE ENERGY CONSUMPTION

ARC has designated Plant Engineering as responsible for implementing an Energy Conservation Plan. Within the directorate, the Plant Engineering Branch is responsible for managing the program and reporting to NASA Headquarters. The Plant Engineering Branch also has the authority to require that some types of projects include energy conservation measures such as energy-efficient lighting, as appropriate.

Below are examples of current operations and maintenance practices at ARC that promote energy and water conservation.

- All space-heating boilers are tested annually and adjusted to maximize combustion efficiency and minimize harmful exhaust emissions.
- All chilled water plants and heat exchangers are tested and cleaned annually to remove scale[6] build-up.
- Existing heating and cooling systems are reviewed and replaced as appropriate with increasingly efficient systems. Replacement equipment is required to meet the state's Title 24 energy standards. Smaller units are specified where new building load calculations warrant, and multiple smaller cooling units have replaced large single plants in some cases. These smaller units are doing a better job of matching the cooling load, thus increasing energy efficiency.
- Roof replacements are designed to meet Title 24 insulation standards, and roof materials are designed to protect the insulation from moisture damage.

ARC has funded many energy conservation measures with general funds and Construction of Facilities funds. Examples include installation of energy-efficient lighting and replacement of HVAC equipment with newer, more efficient, non-chlorofluorocarbon units.

[6] *Scale* is a coating or encrustation formed inside boilers and pipes after extensive use. It forms because of dissolved mineral substances precipitating out of solution, and can lessen conveyance capacity of pipes and interfere with heat transfer in boiler systems, wasting energy.

In March 1992, NASA implemented the Ames Commute Alternatives Program (ACAP) to reduce the number of single-occupant vehicles entering the site, as required by the Bay Area Air Quality Management District. In January 1994, ACAP initiated a Commuter Hotline (650/604-1895) to provide up-to-date general information on commute alternatives. In addition, ACAP coordinates five major incentive programs (carpool parking, onsite transit ticket sales, a transit subsidy, a bicycle program, and shuttle service) all to encourage employees to use alternative transportation during peak commute hours and reduce fuel consumption in vehicles.

ARC has purchased several GEM electric carts used on site.

15.4.2. Commitments for Sanitary Sewer Service and Wastewater Disposal

As part of the programmatic EIS process for the NASA Ames Development Plan, NASA has made the following commitments regarding sanitary sewer service and wastewater disposal.

- NASA will cooperate with the City of Sunnyvale to evaluate the cumulative impact of existing and proposed development on the sanitary sewer conveyance system between ARC and the SWPCP. NASA and its partners will contribute their fair share toward the construction of conveyance pipes and supporting infrastructure that are identified as necessary to mitigate the cumulative impact of existing and proposed development.
- NASA has committed to contributing to the installation of new conveyance piping between the area served by the existing lift station at the Mountain View Golf Course and the PARWQCP, with sufficient capacity to accommodate the total expected flow (approximately 5,486 meters of pipe or 18,000 linear feet). Development under the NASA Ames Development Plan will contribute its fair share to construction costs.
- Because post-development wastewater flow to the PARWQCP has the potential to exceed the amount stipulated in the 1993 agreement (renewed in 1999), the 1993 agreement for flow capacity between the PARWQCP and ARC and between Mountain View and ARC would be amended to address the additional flow expected before commencing any development with the potential to exceed the permitted amount. The agreement with Mountain View would include trigger amounts and a formula for cost sharing.

15.4.3. Mitigation Measures

The NASA Ames Development Plan (NADP) Final Programmatic Environmental Impact Statement (FEIS) identified the mitigation measures to address potential impacts to public services from build out of Mitigated Alternative 5 in the NADP (Design, Community & Environment 2002). For a full discussion of impacts and mitigation measures related to the NADP, see the FEIS.

Chapter 16. Noise and Vibration

16.1. OVERVIEW

This chapter provides an overview of the key topics related to noise at the NASA Ames Research Center (ARC), including a discussion of the basic properties of sound, the health effects of noise, a general overview of noise and human response, noise and weather effects, and the effects of airborne noise-induced vibration. Information throughout this chapter was obtained from the NASA Ames Development Plan Final Programmatic Environmental Impact Statement (Design, Community & Environment 2002). The key technical terms used in this chapter are defined in Table 16-1.

Table 16-1 Definitions of Acoustical Terms

Term	Definitions
Decibel (dB)	A unit describing the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure, which is 20 micropascals (20 micronewtons per square meter).
Frequency (Hz)	The number of complete pressure fluctuations per second above and below atmospheric pressure.
A-Weighted Sound Level (dBA)	The sound pressure level in decibels as measured on a sound level meter using the A-weighting filter network. The A-weighting filter de-emphasizes the very low and very high frequency components of the sound in a manner similar to the frequency response of the human ear and correlates well with subjective reactions to noise. All sound levels in this report are A-weighted, unless reported otherwise.
L_{01}, L_{10}, L_{50}, L_{90}	The A-weighted noise levels that are exceeded 1%, 10%, 50%, and 90% of the time during the measurement period.
Equivalent Noise Level (L_{eq})	The average A-weighted noise level during the measurement period.
Community Noise Equivalent Level (CNEL)	The average A-weighted noise level during a 24-hour day, obtained after addition of 5 decibels in the evening from 7:00 p.m. to 10:00 p.m. and after addition of 10 decibels to CNEL levels measured in the night between 10:00 p.m. and 7:00 a.m.
Day/Night Noise Level (L_{dn})	The average A-weighted noise level during a 24-hour day, obtained after addition of 10 decibels to levels measured in the night between 10:00 p.m. and 7:00 a.m.
L_{max}, L_{min}	The maximum and minimum A-weighted noise level during the measurement period.
Ambient Noise Level	The composite of noise from all sources near and far. The normal or existing level of environmental noise at a given location.
Source: Illingworth and Rodkin in Design, Community & Environment 2002	

16.1.1. NOISE EXPOSURE

Noise exposure measurements are a way of measuring the average dose of noise over a period of time. Noise exposure measurements correlate more closely with human response to noise annoyance than do absolute or instantaneous noise level measurements because they consider both the noise level and the duration of noise events. For this reason, nearly all noise criteria used for land use compatibility are based on noise exposure rather than noise level.

Noise exposure contours show lines of equal noise exposure. Contour values become smaller with distance from the noise source to reflect the reduction of the noise as it travels across the earth's surface. Noise exposure contours will typically be numerically smaller than noise level contours for an individual noise event, since measurements of noise exposure take account of both periods of relative quiet and noise events. Examples of noise exposure descriptors are Community Noise Equivalent Level (CNEL) and day-night average noise level (DNL).

All noise levels and noise exposure levels throughout this document are A-weighted in accordance with appropriate standards and criteria. All such values are in units of decibels, whose unit symbol is "dB" in conformance with American National Standard ANSI/ASME Y10.11-1984. The unit symbol "dBA" is not the standard symbol used under ANSI Y10.11. All numerical noise values in this document symbolized "dB" are numerically identical to those using "dBA," often found in other references. Typical environmental noise levels are shown in Table 16-2.

Table 16-2 . Typical Sound Levels in the Environment and Industry

At a Given Distance Sound Level Subjective From Noise Source	A-Weighted in Decibels Noise Environments Impression	Noise Environments	Subjective Impression
	140		
Civil Defense Siren (100 feet)	130		
Jet Takeoff (200 feet)	120		Pain Threshold
	110	Rock Music Concert	
Diesel Pile Driver (100 feet)	100		Very Loud
	90	Boiler Room	
Freight Cars (50 feet)		Printing Press Plant	
Pneumatic Drill (50 feet)	80		
Freeway (100 feet)		In Kitchen	
Vacuum Cleaner (10 feet)	70	With Garbage Disposal Running	Moderately Loud
	60		
		Data Processing	
Light Traffic (100 feet)	50	Center	
Large Transformer (200 feet)			
	40	Department Store	Quiet
Soft Whisper (5 feet)	30	Private Business	
	20	Office	
		Quiet Bedroom	
	10		Threshold of Hearing
		Recording Studio	
	0		
Source: Illingworth and Rodkin in Design, Community & Environment 2002.			

16.1.2. SOUND PROPAGATION ATTENUATION

Several factors account for sound attenuation, or sound reduction, as it travels from a source.

16.1.2.1. Hemispherical Spreading

Sound is always attenuated by hemispherical spreading, which generally is the reduction of the sound pressure level, or noise level, as the sound travels over a surface, usually the earth. This is the same phenomenon as the intensity of light diminishing with distance from the light source. Hemispherical spreading occurs at the rate of 6 dB per doubling of the distance from the source.

All frequencies of a sound attenuate uniformly over a surface by hemispherical spreading. The results of hemispherical spreading are affected by the directivity characteristics of the sound source.

Complex sound sources emit more sound energy in one direction than another. These effects are much more pronounced close to the source than they are farther away. As the distance from any noise source becomes greater, sound energy emanating from the source becomes more equal in any given direction. Therefore, noise contours drawn to illustrate the sound energy become more circular as they get farther away from the sound source.

16.1.2.2. Air Absorption

Air absorption, unlike hemispherical spreading, attenuates sound at a particular frequency uniformly with distance. Air absorption dramatically affects high-frequency sound while providing little or no attenuation of low frequencies. An example of this phenomena is when aircraft jet engines appear to shrill when up close, but produce only a low roar at distant locations. Though sound is attenuated through air absorption at all times, the degree of attenuation varies with the weather.

16.1.2.3. Sound Refraction

Sound refraction is a bending of sound, typically around some type of barrier, which can either increase or decrease the sound attenuation at a given location. A common example of a barrier that causes sound refraction is a freeway sound wall. Sound walls have the effect of substantially reducing noise to areas immediately protected by the noise barrier, while possibly reflecting the noise to new locations in the immediate vicinity of the barrier. In general, sound walls or other types of barriers have negligible attenuation beyond the noise source or barrier at locations that are more distant. Sound refraction can also be caused by both temperature gradients and by wind.

Sound Refraction by Temperature Gradients

When temperatures are constant with altitude (isothermal conditions), no atmospheric sound refraction occurs. However, when temperatures vary with altitude (temperature gradients), sound refraction can occur.

A negative temperature gradient exists when cooler air is found above warmer air. This typical condition refracts sound waves up and away from the surface of the earth and can attenuate sound by as much as 25 dB at distances less than 0.8 kilometers (0.5 mile).

A positive temperature gradient occurs when warmer air is found above cooler air. This condition, known as thermal inversion or an inversion layer, refracts sound waves toward the surface of the earth. While thermal inversion has little or no effect at short distances, it tends to reduce or eliminate the attenuation effects of ground absorption and barriers over long distances. Thus, sound tends to carry farther under thermal inversion conditions. As a result, this condition can cause substantial increases in noise transmission.

Thermal inversion is known to occur fairly often in the Mountain View area. This effect has contributed to the ongoing dispute between the cities of Palo Alto and Mountain View over Shoreline Amphitheater concert noise. However, temperature gradients are unpredictable and they do not lend themselves to evaluating predictable long-term effects (Miller 1981; Harrison 1980).

Sound Refraction by Wind

Steady, low-velocity wind has a negligible effect on sound propagation. However, high-velocity wind or changes in wind conditions with altitude (wind speed gradients) can produce refractive effects similar to those for temperature gradients. Sound propagation in the direction an item would be carried by the wind (downwind) results in sound waves refracting toward the earth. Like a temperature inversion, this has little or no effect at short distances. However, it does reduce the refractive effects of surface barriers over long distances. Sound propagation upwind refracts the sound up and away from the earth. As with a negative temperature gradient, this may result in additional attenuation of up to 25 dB at distances less than 3 kilometers (1.8 miles).

Both upwind and downwind effects are only measurable for steady long-term average wind velocities in excess of 10 knots (Beranek 1971; Keast 1974). Climatic data for the area indicates that average wind velocity typically exceeds 10 knots for a few hours in the afternoon of the summer months. These north-by-northeast winds may result in some upwind or downwind refraction during these times (ARC 1992; Western Regional Climate Center 1995).

Additionally, gusty winds can scatter sound over large distances; however, this effect is only transitory and cannot be reliably predicted (Miller 1981). Wind can also generate its own noise, such as the rustling of trees, which raises the background noise and may diminish the intrusive effects of a distant noise source.

16.1.3. Airborne Noise-Induced Vibration

One aspect of community response to noise involves high levels of low-frequency airborne sound that can induce building vibration. This phenomenon sometimes occurs in conjunction with ground vibration, as in the case of nearby train passbys, or can occur without perceptible ground vibration, as is typical with wind tunnel or aircraft noise. In this report, only airborne noise-induced vibration will be discussed since ground vibration is not expected to occur (Nelson 1987).

House structures have many components that can readily be excited by noise and respond as complex vibrating systems (Hubbard 1982). Airborne vibration, or "rattling," is usually heard when noise emanates from the following items listed in decreasing likelihood of vibration:

- Windows
- Lightweight, lay-in ceiling tiles
- Walls
- Floors

Dishes, ornaments, and lamps due to the vibration of either the walls or the floors

Additionally, noise-induced vibration can sometimes be felt through windows, walls, or floors by the touch of fingertips and, in extreme cases, damage to the item, such as plaster and tile, could occur from vibration. These phenomena are generally observable with very high sound pressure levels at frequencies below 300 Hz.

16.1.4. Effects of Noise

This section discusses some of the health effects and other responses that can occur because of noise.

16.1.4.1. Hearing Loss

Hearing loss is the primary health risk associated with high noise levels. People who are exposed to an excessive amount of noise develop permanent hearing loss. In most persons, the beginning of noise-induced hearing loss is hard to define, but it follows repeated exposure to industrial or recreational noise, such as loud music. Damage to the inner ear generally does not create pain or any other obvious sensory response or alarm. Loss of hearing can result from exposure to impulse or impact noise, as well as from exposure to steady-state (continuous) noise. The hearing loss caused by excessive exposure to noise is a permanent impairment, and no surgical procedure or medical device can restore the hearing to normal. Thus, prevention is the only way to avoid noise-induced hearing loss (American Family Physician 1992).

The ear is injured by noise in two very different ways, depending on the level of exposure. First, instantaneous peak sound pressure levels in excess of 140 dB can stretch the delicate inner ear tissues beyond their elastic limits, and rip or tear them apart. This type of damage is called acoustic trauma. Second, exposures to noise between 85 and 140 dB damage the ear metabolically, rather than mechanically. In this case, the potential for damage and hearing loss depends on the levels and the duration of exposure. This type of injury is called noise-induced hearing loss (NIHL). In contrast to acoustic trauma, it is cumulative and grows over years of exposure.

Hearing damage has been studied extensively in the United States, resulting in the noise exposure standards of the Department of Labor's Occupational Safety and Health Administration (OSHA). Additionally, the NASA Health Standard on Hearing Conservation (NHS/IH-1845.4) establishes minimum requirements for hearing protection. Both of these regulatory mechanisms are discussed in more detail in Section 16.2.

16.1.4.2. Non-Auditory Health Effects

Short-term exposure studies have demonstrated that noise is capable of eliciting a variety of acute physiological and biochemical responses in humans. These responses appear to represent a generalized biologic stress reaction involving sympathetic activation of the autonomic nervous system. These include symptoms such as an increase in blood pressure, other forms of physical stress, and an overall increase in psychological stress.

Physical stress reactions can be observed when people are exposed to noise levels of 85 dB or more. Dilated pupils, elevated blood pressure, and an increase of stomach acid leading to a nauseous feeling are typical reactions when the noise environment is increased above those levels normally found in a community noise environment. There is disagreement among experts as to whether these reactions pose a threat to health with long-term exposure.

Psychological stress varies from individual to individual. This type of stress can be caused by sleep disturbance, inability to carry on a conversation, or other annoying factors of noise. The community standards described in Section 16.2 have been designed for sleep protection. When a noise environment exceeds these standards, sleep disturbance, and thus psychological stress, may occur. It difficult to have a normal conversation in noise above 65 dB without raising one's voice, and could cause psychological stress in certain individuals.

16.1.4.3. Noise and Human Response

It is widely recognized that human response to noise is subjective and varies considerably among individuals. Unfortunately, there is no completely satisfactory way to measure the subjective effects of noise, or of the corresponding reactions of annoyance and dissatisfaction. This is primarily because of the wide variation in individuals' thresholds of annoyance, habituation to noise, and differing past experiences with noise. An important factor in assessing a person's subjective reaction to noise is comparing existing noise to proposed noise. Generally, the more a new noise exceeds existing noise, the less acceptable it is to the community. Therefore, a new noise source would be judged more annoying in a quiet area than it would in be in a noisier location. Knowledge of the following relationships is helpful in understanding how changes in noise and noise exposure are perceived.

- Except under special conditions, a change in sound level of 1 dB cannot be perceived
- Outside of the laboratory, a 3 dB change is considered a just-noticeable difference
- A change in level of at least 5 dB is required before any noticeable change in community response would be expected

A 10 dB change is subjectively heard as an approximate doubling in loudness and often causes an adverse community response

Noise and land use compatibility guidelines generally correlate with widely accepted annoyance levels of a community. These regulations are discussed in more detail in Section 16.2.

16.2. REGULATORY REQUIREMENTS

16.2.1. HEARING CONSERVATION STANDARDS

Given the concerns outlined in Section 16.1, OSHA has developed noise exposure standards for United States workers. These noise exposure standards allow for noise levels of 90 dB for 8 hours per day and decreasing exposure duration for higher noise levels up to a maximum of 115 dB for 15 minutes or less without hearing protection. These standards apply to virtually all industries within the United States (Department of Labor Occupational Noise Exposure Standard. 29 CFR. Part 1910, Subpart G).

The NASA Health Standard on Hearing Conservation (NHS/IH-1845.4) establishes minimum requirements for the NASA Agency-wide Hearing Conservation Program. This standard is applicable to all NASA employees and NASA-controlled, government-owned facilities. Permissible exposure limits outlined by the NASA Hearing Conservation Program vary with the sound pressure level of the noise, as detailed in Table 16-3. It is NASA policy to control noise generated by NASA operations and to prevent occupational noise-related hearing loss. In accordance with this policy, maximum permissible exposure limits have been established to provide an environment free from hazardous noise.

Table 16-3 Permissible Exposure Limits for Noise According to NASA's Hearing Conservation Program

Duration (Hours)	dBA
16	80
8	85
4	90
2	95
1	100
0.5	105
0.25	110
0.125 or less	115

The Hearing Conservation Program establishes a noise hazard area as any work area with a noise level of 85 dBA or greater. Thus, NASA's program is 5 dB more stringent than OSHA's. Earmuffs or earplugs are to be provided to attenuate employee noise exposure to a level below 85 dBA. A combination of both earmuffs and earplugs are to be required where noise levels equal or exceed 110 dBA.

16.2.2. LAND USE HEARING CONSERVATION STANDARDS

The nuisance effects of noise have traditionally been addressed in terms of noise annoyance. This annoyance is known to be associated with the level of noise, the duration of the noise, and increased sensitivity to evening and nighttime noise. Since 1972, when Congress enacted the Noise Control Act (NCA) (Public Law 92-574 [42 USC. 4901 et seq.]), several documents have been published that provide guidance on assessing the nuisance and annoyance effects of noise and related land use compatibility issues. The following is a summary of the documents most applicable to assessing noise and land use compatibility for ARC.

- Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety (1974). The NCA of 1972 required the EPA to publish information on acceptable community noise levels. The result was EPA550/9-47-004, which is commonly referred to as the "Levels Document." This document establishes the DNL as the preferred community noise descriptor, with DNL values being directly related to the percentages of the community that would be annoyed by particular noise exposures.

- Guidelines for Considering Noise in Land Use Planning and Control (1980). In late 1979, the Federal Interagency Committee on Urban Noise (FICUN) was formed to unify noise policy among various federal agencies. In 1980, it published Guidelines for Considering Noise in Land Use Planning and Control, which confirms DNL as the descriptor to be used for all noise sources. In 1992, a second interagency committee, the Federal Interagency Committee on Noise (FICON), published its Federal Agency Review of Selected Airport Noise Analysis Issues, which again confirms DNL as the best cumulative noise exposure measurement.
- Sound Level Descriptors for Determination of Compatible Land Use (1990). In 1990, the American National Standard Institute (ANSI) revised its 1980 standards for sound level descriptors for land use compatibility assessment to confirm DNL as the acoustical measure for assessing compatibility between various land uses and the outdoor noise environment.

General Plan Guidelines (1990). Also in 1990, the California Governor's Office of Planning and Research (OPR) published guidelines to aid California municipalities in preparing their general plans. This document uses the CNEL and DNL noise descriptors interchangeably to relate land use compatibility for community noise environments.

The most commonly used noise exposure measure for environmental noise is DNL, or L_{dn}. This is a night-penalized average used for most noise and land use compatibility criteria. The day-night average sound level is obtained after the addition of 10 dB to noise levels measured in the night between 10:00 p.m. and 7:00 a.m. In California, an alternative measure is the CNEL, which is similar to DNL except a 5 dB penalty is added during the evening hours of 7:00 p.m. to 10:00 p.m. Because DNL and CNEL nearly always render results within 1 dB, they can generally be compared in land use compatibility analyses.

In general, noise criteria apply to land use compatibility for new development. These criteria are specified in terms of exterior noise levels, although the noise-sensitive area may be indoors. Various methods exist for the accurate prediction of sound transmission loss and sound level reduction to the indoor environment. Noise criteria are presented in this document in exterior noise levels.

No state or local noise criteria are binding on the type of noise to be created by ARC. NASA attempts, whenever possible, to meet local guidelines and standards and considers them as advisory in nature. Despite the lack of binding regulation, NASA uses the following noise guidelines and regulations to provide guidance for determining the relative impact of operations and related activities.

- *Federal Criteria.* Three federal criteria provide guidance in determining noise impacts. These are the noise criteria from the Department of Housing and Urban Development (HUD), those from the Federal Aviation Administration (FAA), and guidelines created by the Army.
- *State Criteria.* The State of California Guidelines for preparation of Noise Elements of General Plans and the Caltrans Division of Aeronautics noise exposure criteria provide guidance in determining noise effects.
- *Local Criteria.* Local criteria that provide guidance near ARC include noise criteria from the cities of Mountain View and Sunnyvale, and Santa Clara County.

Specific federal, state, and local land use compatibility noise criteria are described below and are summarized in Table 16-4. These noise criteria are written for various purposes. The levels provided by federal agencies, such as HUD and the FAA, are to be used as general planning guidelines, considering cost and feasibility, along with health and welfare. HUD levels also determine if proposed sites are eligible for HUD insurance or financial assistance. The State of California Planning Guidelines were prepared as an information document to provide communities with a means of quantifying noise environments. The California Division of Aeronautics' regulation deals specifically with land use compatibility around airports. The Santa Clara County, Sunnyvale, and Mountain View criteria apply to proposed new construction. The overlap in noise exposure values over several degrees of acceptability show the variation in community acceptability to noise exposure.

16.2.2.1. Federal Noise Criteria

For residential land use, outdoor DNL or CNEL below 65 dB is considered acceptable, according to HUD and FAA. According to FAA, DNL values below 70 dB are normally acceptable for commercial land use. Commercial land use is conditionally acceptable between 70 dB and 80 dB, while industrial land use in areas below DNL values of 85 dB is normally acceptable. Open space use is to occur in areas below 75 dB. HUD does not detail noise criteria for land uses other than residential.

Additionally, the U.S. Army provides guidance on noise and compatible land uses (U.S. Army Center for Health Promotion and Preventative Medicine 2001). Criteria for rating noise will be those from *Guidelines for Considering Noise in Land Use Planning and Control* by the Federal Interagency Committee on Urban Noise (1980).

Table 16-4 Land Use Compatibility Noise Exposure Criteria

		Residential		Commercial		Industrial		Open Space	
Sources	Measure	Normally Acceptable	Conditionally Acceptable	Normally Acceptable	Conditionally Acceptable	Normally Acceptable	Conditionally Acceptable	Normally Acceptable	Conditionally Acceptable
Department of Housing and Urban Development (HUD)	DNL	<65	65–75	–	–	–	–	–	–
Federal Aviation Administration (FAA)	DNL/ CNEL	<65	–	<70	70–80	<85	–	<75	–
U.S. Army	DNL/ CNEL	<65	65–75	<70	70–80	<85	–	<75	–
California Planning Guidelines	DNL/ CNEL[1]	<60	55–70	<70	67.5–77.5	<75	70–80	<70–75	67.5–80
California Division of Aeronautics	CNEL[2]	<65	65–70	–	–	–	–	–	–
City of Mountain View	DNL/ CNEL	<55	55–65	<60	60–70	<65	65–75	<55	55–65
City of Sunnyvale	DNL/ CNEL	<60	60–70	<65	65–77.5	<70	70–80	<70	
Santa Clara County	DNL	<55	55–65	<65	65–75	<70	70–75	<55	55–80

1. Uncorrected CNEL.
2. Annual average.
– = No criteria for this land use.
Source: NASA Ames Aerodynamics Testing Program 1998 (in Design, Community & Environment 2002).

16.2.2.2. State Noise Criteria

The California State Planning Guidelines (Figure 16-1) show DNL or CNEL values below 60 dB to be acceptable for residential land use, and values below 70 dB as acceptable for commercial land use. Industrial land use in areas below DNL values of 75 dB is also acceptable. Open space use is acceptable in areas below 70 dB, depending upon the specific nature of the space; for example, playgrounds are acceptable up to 70 dB and golf courses are acceptable up to 75 dB. The California Division of Aeronautics considers residential DNL values below 65 dB to be acceptable.

Figure 16-1 Land Use Compatibility for Community Noise Environments

16.2.2.3. Local Noise Criteria

The City of Mountain View has one of the strictest residential noise standards of any municipality in California for residential land use. A DNL below 55 dB is specified for new construction, although many residences throughout the city are already exposed to more severe noise environments. The commercial and industrial land use criteria are 60 dB.

In addition to the noise exposure criteria in the Mountain View Noise Element, a noise ordinance is also referenced in the Noise Element and applied by the city. It specifies a

55 dB maximum noise level from stationary emitters in the City of Mountain View when measured at residential property lines during the daytime and 50 dB during the nighttime (10:00 p.m. to 7:00 a.m.).

The Sunnyvale criteria follow the state guidelines rather closely, the only exception being open space use, which is to occur in areas below a DNL of 70 dB. The authors of the Sunnyvale Noise Supplement indicated that DNL should be interpreted as the yearly average throughout their document.

Like Mountain View, Santa Clara County follows the lowest noise acceptability limits found in California for residential land use, at a DNL of 55 dB.

16.3. REGIONAL SETTING

This ERD encompasses the entire ARC, a federal facility located on approximately 800 hectares (2,000 acres) of land between U.S. Highway 101 and the southwestern edge of the San Francisco Bay in the northern portion of Santa Clara County, California. The City of Mountain View borders it to the south and west, and the City of Sunnyvale to the south and east. ARC is about 56 kilometers (35 miles) south of San Francisco and 16 kilometers (10 miles) north of San Jose, in the heart of Silicon Valley. Figure 1-1 shows the regional context of the site and Figure 1-2 shows the local context. For planning purposes, ARC is divided into four subareas: the NASA Research Park, Eastside Airfield, Bayview, and the Ames campus (Figure 1-3).

The closest residential land use is the Department of Defense housing currently operated by the U.S. Army Corps of Engineers and located in close proximity to the 40- by 80-Foot Wind Tunnel and 80- by 120-Foot Wind Tunnel. The other land uses directly adjacent to the site are office, industrial, and open space. In addition, within approximately 610 meters (2,000 feet) is Santiago Villa, an existing mobile home facility. The next nearest residential land uses are on the south side of U.S. Highway 101. The most sensitive land uses are the residential uses. Office use is the next most sensitive land use, and the least sensitive land uses are commercial/industrial uses.

16.4. EXISTING SITE CONDITIONS

This section describes the existing noise environment at ARC. Noise exposure contours and levels presented in this section were determined from NASA measurement surveys taken over the past 15 years and noise monitoring conducted during preparation of the NADP EIS.

Noises generated by ARC and Moffett Field have historically been a source of complaints from surrounding areas. Noise produced by many of the wind tunnels and aircraft operations generate complaints from residents off site. Figures showing noise contours described in this section all occur at the end of this section.

16.4.1. WIND TUNNELS

Among NASA's wind tunnels, the primary noise generators include:

- **40- by 80-Foot Wind Tunnel**. The 40- by 80-Foot Wind Tunnel is a closed-circuit wind tunnel. A typical test day can consist of one or two shifts, day or night. Each test shift averages approximately 4 hours, with the wind tunnel running. Current noise exposure levels from this facility are presented in Figure 16-2.
- **80- by 120-Foot Wind Tunnel.** The 80- by 120-Foot Wind Tunnel is a non-return wind tunnel that shares the same drive system as the 40- by 80-Foot Wind Tunnel. Because both facilities use the same drive system, only one can be operated at a time. Figure 16-3 shows the current noise exposure levels for the 80- by 120-Foot Wind Tunnel.
- **Unitary Plan Wind Tunnels.** The Unitary Plan Wind Tunnel complex consists of three wind tunnels, the 11-foot, the 9- by 7-foot, and the 8- by 7-foot. Only one of these tunnels can be used at a time. At present, only the 11-foot tunnel is regularly used. The 9- by 7-foot Supersonic Wind Tunnel and the 8- by 7-foot Supersonic Wind Tunnel are currently not in operation. Noise levels were measured during operation of the 11-foot Transonic Wind Tunnel in October 2000. Measured noise levels ranged from 80 to 85 dBA along Wagner Lane at distances of 15 to 20 meters (50 to 75 feet) west of the facility. Noise levels along Mark Avenue between Wagner Lane and Boyd Road typically range from 75 to 79 dBA. Noise levels were measured inside the lobby of Building N-234 on Boyd Road directly east of the wind tunnel. The measured noise level was 48 dBA and the operating tunnel was barely audible. Noise levels along DeFrance Avenue were measured at several locations north of the facility and typically ranged from 65 to 70 dBA. Figure 16-4 shows the current noise exposure levels for the complex.
- **12-Foot Pressure Wind Tunnel.** The 12-foot Pressure Wind Tunnel also generates noise. Noise levels measured for NASA worker exposure evaluations provide some data for the tunnel. The measured noise levels are 90 dBA at 61 meters (200 feet) from the tunnel at Bushnell Street and 80 to 90 dBA at the cooling towers located north, south, east, and west of the facility. Figure 16-5 shows the noise exposure contours for the 12-foot Pressure Wind Tunnel. (This wind tunnel is not currently in operation.)

16.4.2. ARC JETS

The arc jet facility is used to perform high temperature materials tests. Noise levels were measured during operation of the arc jets in June 2001. Measured noise levels reached 80 dBA at a distance of 50 meters (146 feet) north of the facility, 78 dBA at a distance of 75 meters (246 feet) to the east of the cooling towers, and 75 dBA along Boyd

Road south of the facility. Figure 16-6 shows the noise exposure levels for the arc jets facility.

16.4.3. AIRFIELD OPERATIONS, TRAFFIC, AND OTHER EXISTING NOISE SOURCES

In addition to the wind tunnels, Outdoor Aerodynamic Research Facility (OARF), and arc jets, there are several other noise sources at and beyond the ARC that affect the four planning areas and the surrounding community, most notably airfield operations and traffic noise from local highways.

ARC is home to a variety of government-related aircraft. Noise from Moffett Federal Airfield has been evaluated for the period from 1999 to 2010 (P&D Consultants, Inc. et al. 2000). Noise exposure contours were determined in terms of CNEL. Figure 16-7 shows noise contours from NASA baseline aircraft operations.

Ambient traffic noise measurements were made during the preparation of the NASA Ames Development Plan Final Programmatic Environmental Impact Statement at four locations within the ARC. Figure 16-8 shows the locations of the noise measurements. Noise levels were measured adjacent to U.S. Highway 101 at an exposed location along South Perimeter Road (S1), in a location protected by a sound wall at Westcoat Court (S2), and at a distance from the highway near Building N-547C on Girardi Road (S3) to determine how noise levels decrease over distance. The final measurement was conducted at the intersection of Cody Road and Severns Avenue (S4). The data gathered during these measurements is summarized in Table 16-6. The existing DNL noise exposure contours resulting from traffic are shown in Figure 16-9.

16.4.4. COMPOSITE NOISE EXPOSURE CONTOURS

Composite noise exposure contours of existing noise conditions at ARC are presented in Figure 16-10. These contours were developed using the following information:

- Moffett Field airstrip CNEL Noise Exposure, 1999
- Noise measurement along U.S. Highway 101
- Noise measurement of the Unitary Plan Wind Tunnel
- NASA Ames Aerodynamic Testing Project EIS

Noise measurement of the arc jets

Thus, Figure 16-11 represents a composite of noise contours from all of these noise sources.

Table 16-5 Ambient Traffic Noise Levels

Location	Leq	L(10)	L(50)	L(90)	Dominant Noise Source
S1: Recreation Fields south of Dailey Road; microphone 5 feet above grade	74	76	73	72	U.S. Highway 101 traffic
S2: Westcoat Court; 50 feet from the property line; microphone 5 feet above grade	68	69	67	66	U.S. Highway 101 traffic
S3: Building N-547C; microphone 5 feet above grade	56	57	55	54	U.S. Highway 101 traffic
S4: Cody Road at Severns Road; microphone 5 feet above grade	53	57	50	49	U.S. Highway 101 traffic
Source: Illingworth and Rodkin in Design, Community & Environment 2002.					

16.4.5. OUTDOOR AERODYNAMIC RESEARCH FACILITY

OARF is located in the Bay View area and is used to obtain a wide range of hover and acoustic data on full-scale or small-scale aircraft and other aerospace components. High noise-generating projects, such as powered model tests, run an average of 2 hours per day when the facility is in operation. Other tests have been administered at the facility for up to 7 hours per day.

The experimental physics branch of ARC recently tested hybrid rocket fuel motors at OARF. NASA staff measured rocket fuel test noise levels in September 2001 (Kaswani personal communication). The orientation for the rocket test rig and measured noise levels are shown on Figure 16-11. The measured noise levels reflect the effects of orienting the facility to mitigate potential noise impacts. The noise levels are generated for very short time intervals, approximately 10 to 20 seconds.

16.5. ENVIRONMENTAL MEASURES

NASA and ARC have identified the following environmental measures that are designed to address potential air quality effects of operations and future development at ARC and are implemented to the extent feasible.

16.5.1. MITIGATION MEASURES

The NASA Ames Development Plan (NADP) Final Programmatic Environmental Impact Statement (FEIS) identified the following mitigation measures to address potential noise impacts from build out of Mitigated Alternative 5 in the NADP (Design, Community & Environment 2002). For a full discussion of impacts and mitigation measures related to the NADP, see the FEIS.

16.5.1.1. Mitigation Measure NOISE-1a

For development on NRP Parcels 2, 4, 9,10, 11, 12, 12a, and 16, and the Ames Campus, noise mitigation measures, including site planning to protect noise sensitive outdoor activity areas and building sound insulation treatments to protect noise sensitive indoor spaces, would be included in project design and development. Buildings would be designed to provide an appropriate Noise Level Reduction (NLR) depending upon the designated uses of the sensitive spaces.

16.5.1.2. Mitigation Measure NOISE-1b

Residential development proposed on Parcels 6, 12, and 12a would be designed so as to achieve an indoor DNL of 45 dB or less. The housing would be provided with forced-air mechanical ventilation or air-conditioning as necessary to achieve a habitable interior environment with the windows closed.

16.5.1.3. Mitigation Measure NOISE-2a

For development on parcels in the Bay View area near the OARF, noise mitigation measures including site planning to protect noise sensitive outdoor activity areas and building sound insulation treatments to protect noise sensitive indoor spaces would be included in project design and development. Buildings would be designed to provide an appropriate Noise Level Reduction (NLR) depending upon the designated uses of the sensitive spaces.

16.5.1.4. Mitigation Measure NOISE-2b

Once development occurs in the Bay View area, NASA would operate the OARF so that noise generated by it would not exceed the following levels when measured on any residential property:

Table 16-6 OARF Operational Noise Level Restrictions

	Lmax	**L(eq-hour)**
Daytime (7 am - 10 pm)	70	50
Nighttime(10 pm - 7 am)	65	45
Design, Community & Environment 2002.		

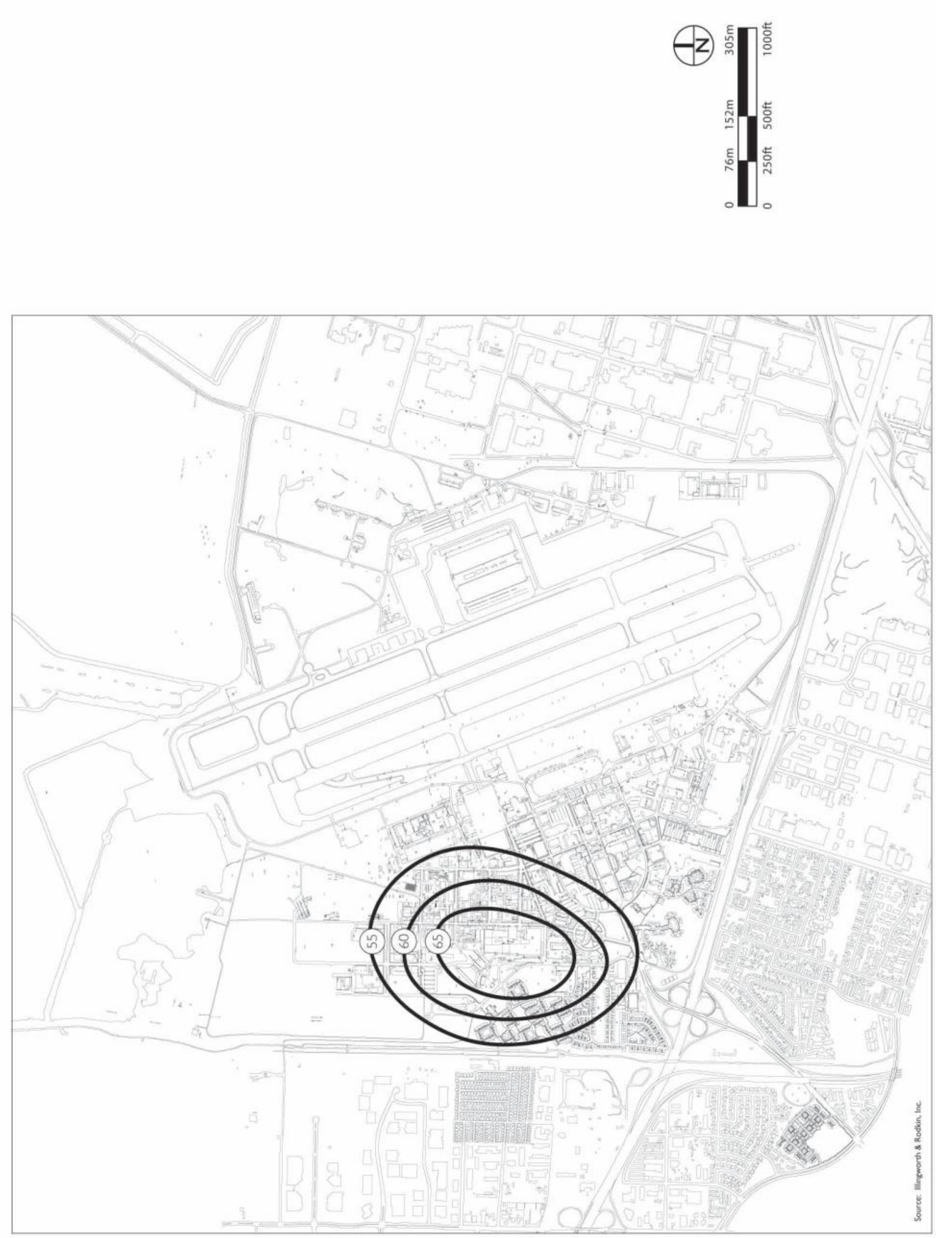

Figure 16-2 Existing 40-By-80-Foot Wind Tunnel Operations: Annual Ldn Noise Exposure Contours (dB)

Figure 16-3 Existing 80-By-120-Foot Wind Tunnel Operations: Annual Ldn Noise Exposure Contours *(dB)*

Figure 16-4 Unitary Plan Wind Tunnel: Annual Ldn Noise Exposure Contours (dB)

Figure 16-5 12 Foot Pressure Wind Tunnel: Annual Ldn Noise Exposure Contours (dB)

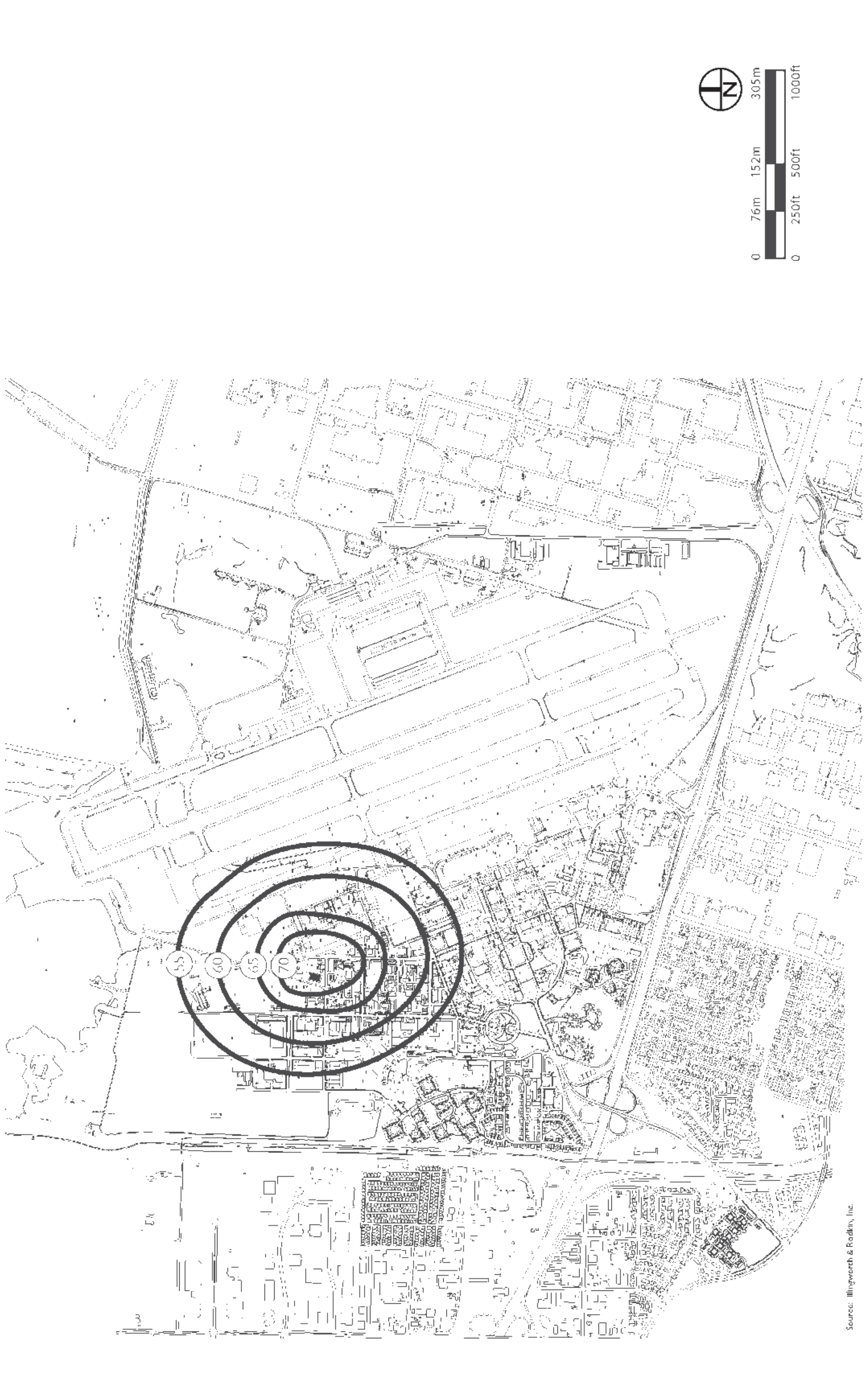

Figure 16-6 Arc Jets: Annual Ldn Noise Exposure Contours (dB)

Figure 16-7 Airfield CNEL Noise Exposure (dB) (Applicable to both 1999 and 2010)

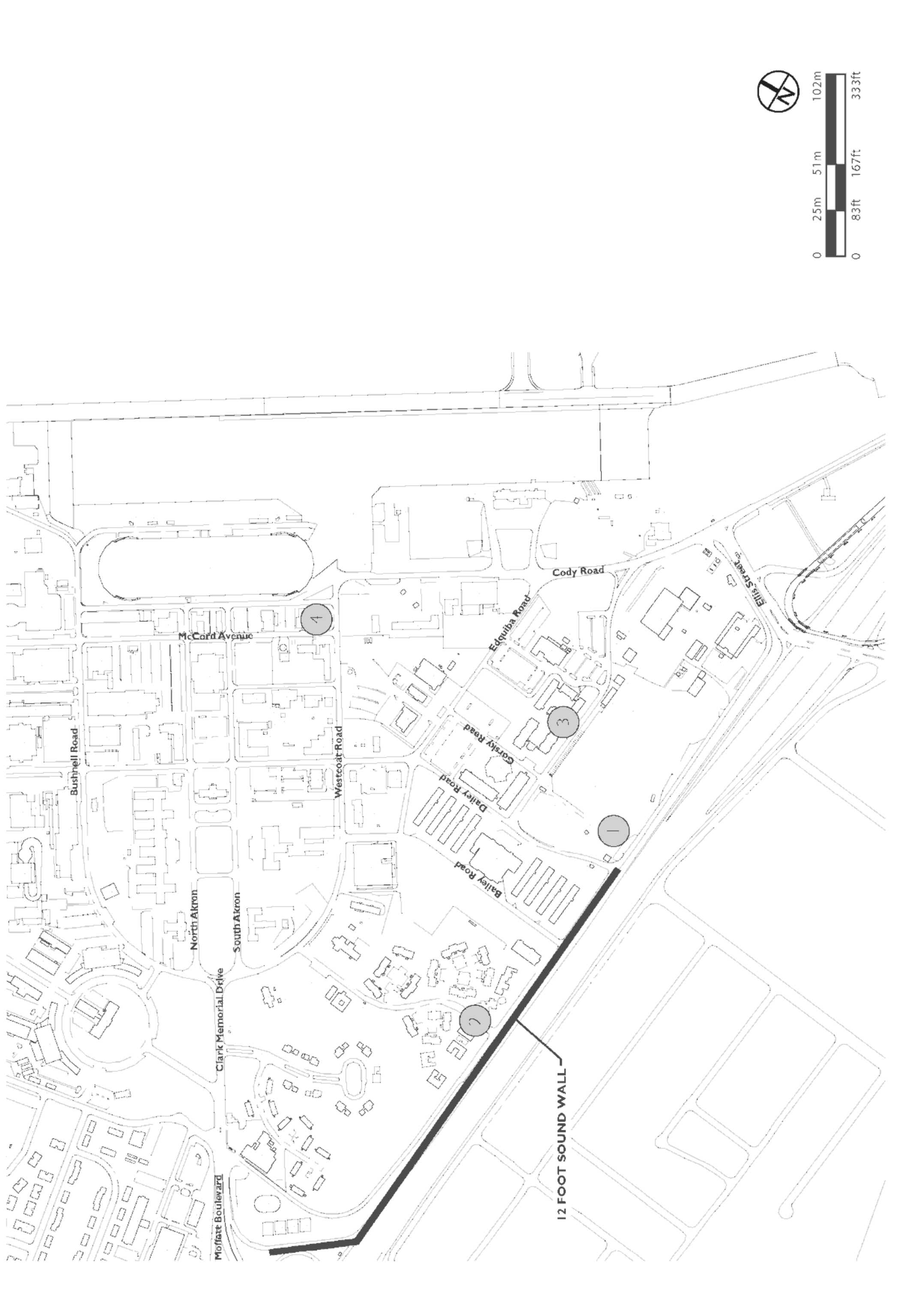

Figure 16-8 Location Of Ambient Traffic Noise Measurements

Figure 16-9 Ambient Highway 101 Traffic: Annual Ldn Noise Exposure Contours (dB)

Figure 16-10 Composite Annual Ldn Noise Exposure Contours (dB)

Figure 16-11 Hybrid Rocket Fuel Test Facility Noise Levels

Chapter 17. Hazardous Materials

17.1. OVERVIEW

The NASA Ames Research Center (ARC), including Resident Agencies, uses a wide variety of hazardous materials for research and operations. Both ARC and Resident Agencies are responsible for regulatory compliance at the site. Resident Agency organizations are responsible for obtaining hazardous materials permits required for their operations and preparing emergency response plans and procedures, or they may pay NASA for the services. These organizations are required to comply with the same regulations as ARC. The polychlorinated biphenyl (PCB) and radiation safety programs are managed collectively over the entire ARC site.

In addition, NASA is dedicated to sustaining an effective environmental protection culture. A significant aspect of that culture is pollution prevention. NASA's pollution prevention strategy is to eliminate or reduce the use of hazardous substances, to reuse or recycle hazardous materials, to dispose of hazardous materials and hazardous waste in an environmentally safe manner, to buy recycled products, and to recycle.

This chapter describes the use of chemicals, including PCBs, radioactive, and other materials broadly categorized as hazardous materials, as well as NASA's pollution prevention practices. Information regarding hazardous materials was obtained from the NASA Ames Development Plan Final Programmatic Environmental Impact Statement (Design, Community & Environment 2002).

17.2. REGULATORY REQUIREMENTS

Hazardous materials, as defined by the California Department of Toxic Substances Control (DTSC), are any materials that, because of their quantity, concentration, physical, or chemical characteristics, pose a significant present or potential hazard to human health and safety or to the environment if released into the workplace or the environment. Extremely or acutely hazardous materials are materials that may cause rapid death, permanent injury, or persistent harm to the environment. Lists of these chemicals include the Superfund Amendment Reauthorization Act (SARA 313) list, the Occupational Safety and Health Administration's (OSHA's) list of highly hazardous chemicals (29 Code of Federal Regulations [CFR] 1910.119 Appendix A), OSHA-regulated carcinogens (29 CFR 1910 Subpart Z), and select carcinogens and reproductive toxins (defined in 29 CFR 1910.1450).

17.2.1. FEDERAL REGULATIONS

The principal federal regulatory agency responsible for the safe use and handling of hazardous materials is the U.S. Environmental Protection Agency (EPA). Two key federal regulations pertaining to hazardous wastes are described below. The federal regulations are specified in CFR, specifically Title 29, Occupational Safety and Health Administration; Title 40, Environmental Protection; and Title 49, Hazardous Materials Transportation.

NASA has developed a strategic plan to guide its facilities in compliance with Executive Order 12856, *Federal Compliance with Right-to-Know Laws and Pollution Prevention*. The executive order, adopted August 3, 1993, sets out to ensure federal facility compliance with the chemical reporting requirements of the Emergency Planning and Community-Right-to-Know Act of 1986 (42 U.S.C. Sections 11001–11050) and the requirements of the Pollution Prevention Act of 1990 (42 U.S.C. Sections 13101–13109).

17.2.1.1. Resource Conservation and Recovery Act

The Resource Conservation and Recovery Act enables EPA to administer a regulatory program that extends from the manufacture of hazardous materials to their disposal, thereby regulating the generation, transport, treatment, storage, and disposal of hazardous waste at all facilities and sites in the nation.

17.2.1.2. Comprehensive Environmental Response, Compensation, and Liability Act

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), also known as Superfund, was passed to facilitate the cleanup of the nation's toxic waste sites. In 1986, Superfund was amended by the Superfund Amendment and Reauthorization Act Title III (community right-to-know laws). Title III states that past and present owners of land contaminated with hazardous substances can be held liable for the entire cost of the cleanup even if the material was dumped illegally when the property was under different ownership.

17.2.1.3. Toxic Substances Control Act

PCBs are regulated under the Emergency Planning and Community Right-to-Know Act (40 CFR 350-372); PCB Manufacturing, Processing, Distribution in Commerce and Use Prohibitions (40 CFR 761); Toxic Substances Control Act (PL-94-469); and Executive Orders (12088, 12580, and 12856).

17.2.2. STATE REGULATIONS

California regulations are equal to or more stringent than federal regulations. EPA has granted the state primary oversight responsibility to administer and enforce hazardous waste management programs. State regulations require planning and management to ensure that hazardous wastes are handled, stored, and disposed of properly to reduce risks to human health and the environment. State regulatory requirements are found in the California Health and Safety Code, and the California Code of Regulations (CCR), Titles 22 and 26. California's state hazardous materials regulations include the California Hazardous Waste Requirements (22 CCR 66261–66268, 67426–66429, and 67780).

17.2.2.1. Hazardous Materials Release Response Plans and Inventory Act of 1985

The Hazardous Materials Release Response Plans and Inventory Act, also known as the Business Plan Act, requires businesses using hazardous materials to prepare a hazardous materials business plan that describes their facilities, inventories, emergency response plans, and training programs. *Hazardous materials* are defined as raw or unused materials that are part of a process or manufacturing step. They are not considered hazardous waste. Health concerns pertaining to the release of hazardous materials, however, are similar to those relating to hazardous waste.

17.2.2.2. Hazardous Waste Control Act

The Hazardous Waste Control Act created the state hazardous waste management program, which is similar to, but more stringent than, the federal Resource Conservation and Recovery Act program. The act is implemented by regulations contained in 26 CCR, which describes the following required aspects for the proper management of hazardous waste:

- Identification and classification
- Generation and transport
- Design and permitting of recycling, treatment, storage, and disposal facilities
- Treatment standards
- Operation of facilities and staff training
- Closure of facilities and liability requirements

These regulations list more than 800 materials that may be hazardous and establish criteria for their identification, packaging, and disposal. Under the Hazardous Waste Control Act and 26 CCR, the generator of hazardous waste must complete a manifest that accompanies the waste from the generator to the transporter to the ultimate disposal location. Copies of the manifest must be filed with DTSC.

17.2.2.3. Emergency Services Act

Under the Emergency Services Act, the state developed an emergency response plan to coordinate emergency services provided by federal, state, and local agencies. Rapid response to incidents involving hazardous materials or hazardous waste is an important part of the plan, which is administered by the California Office of Emergency Services. The office coordinates the responses of other agencies, including the EPA, California Highway Patrol, regional water quality control boards (RWQCBs), air quality management districts, and county disaster response offices.

17.2.2.4. California Occupational Safety and Health Administration Standards

Worker exposure to contaminated soils, vapors that could be inhaled, or possibly groundwater containing hazardous levels of constituents would be subject to monitoring and personal safety equipment requirements that are established in California Occupational Safety and Health Administration (Cal/OSHA) regulations (Title 8) and specifically address airborne contaminants. Site controls pertaining to asbestos and lead exposure during construction activities are also included in Cal/OSHA regulations. The primary intent of the Title 8 requirements is to protect workers, but compliance with some of these regulations would also reduce potential hazards to nonconstruction workers and project area occupants because required site monitoring, reporting, and other controls would be in place.

Workers who are in direct contact with soil or groundwater containing hazardous levels of constituents would perform all activities in accordance with a hazardous operations site-specific health and safety plan (HSP), as outlined in Cal/OSHA standards. An HSP is not required for workers such as heavy equipment operators, carpenters, painters, or other construction workers who would not be performing investigation or remediation activities where direct contact with materials containing hazardous levels of constituents could occur. However, elements of an HSP protect those workers who may be adjacent to cleanup activities by establishing engineering controls, monitoring, and security measures to prevent unauthorized entry to cleanup sites and to reduce hazards outside the investigation/cleanup area.

In addition to an HSP, Cal/OSHA requires that contaminated sites listed under the National Priorities List must have a risk management plan (RMP) reviewed and approved by the RWQCB and administered by the responsible party. The RMP identifies specific measures to reduce potential risks to human and ecological populations during construction of the proposed project for each site or group of sites to be developed. The RWQCB follows EPA guidelines for risk management. EPA and DTSC guidelines divide potential human health risks associated with exposure to chemicals into cancer risks and noncancer hazard indices. The calculated cancer risk characterizes health risks due to exposure to carcinogenic substances by using estimated or measured concentrations and risk/potency factors. The calculated cancer risk approximates the probability of an individual developing cancer over the course of a lifetime due to exposure to a particular cumulative dose of a potential carcinogen.

Unlike cancer risk estimates, the measure used to describe the potential for noncarcinogenic toxic effects to occur is expressed in terms of a hazard index (HI), which is calculated as the ratio of the predicted acute or chronic exposure (dose) of a noncarcinogenic substance to that chemical's toxicity threshold, often referred to as the reference dose. The HI assumes that there is a level of exposure below which it is unlikely, even for sensitive populations, to experience adverse health effects. Because there are inherent uncertainties and assumptions used in the modeling, the final calculated risk value should therefore be viewed as a very conservatively estimated probability of occurrence. The HIs for the project site will be determined before construction by the lead agency in the site's cleanup process.

17.2.3. Local Regulations

The Santa Clara County Department of Environmental Health regulates hazardous material storage and use at ARC. The regulatory requirements are specified in the Hazardous Materials Storage Ordinance (County of Santa Clara, November 15, 1983) and the Toxic Gas Storage Ordinance NS-517.44 (County of Santa Clara).

All hazardous material storage areas are permitted by the County of Santa Clara based on the individual facility, the maximum quantity of the material stored, and by its hazard class. Typical hazard classes found at ARC are compressed gases, flammable liquids and solids, oxidizers, organic peroxides, poisons, corrosives, and other regulated materials. The permits are compared with current inventories annually to ensure that the appropriate permits are maintained for each facility at ARC.

17.2.4. Other Laws, Regulations, and Programs

Various other state regulations have been enacted that affect hazardous materials management, including:

- Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65), which requires labeling of substances known or suspected by the state to cause cancer
- California Government Code Section 65962.5, which requires the Office of Permit Assistance to compile a list of possible contaminated sites in the state
- State and federal regulations also require that hazardous materials sites be identified and listed in public records. These lists include:
- Comprehensive Environmental Response, Compensation, and Liability Information System
- National Priorities List for Uncontrolled Hazardous Waste Sites
- Resource Conservation and Recovery Act
- California Superfund List of Active Annual Workplan Sites

- Lists of state-registered underground and leaking underground storage tanks
- The following is a specific list of regulatory drivers for the Ames Pollution Prevention Program:
- Emergency Planning and Community-Right-to-Know Act of 1986 (Public Law 99-499)
- Superfund Amendments and Reauthorization Act, Title III, Sections 312 and 313
- Pollution Prevention Act of 1990 (42 U.S.C. 13101 et seq.)
- Resource Conservation and Recovery Act of 1976, as amended by the Hazardous and Solid Waste Amendments of 1984 (42 U.S.C. 6002)
- Executive Order 13101 of September 14, 1998, Greening the Government Through Waste Prevention, Recycling, and Federal Acquisition
- Executive Order 12856 of August 3, 1993, Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements, Sections 3-304 and 3-302
- NASA Procedural Requirements, NPR 8830.1, Affirmative Procurement, February 1, 1999. Hazardous Waste Source Reduction and Management Review Act of 1989 (Senate Bill 14), CCR Title 22, Sections 67100.4, 67100.5
- Executive Order 13148, Greening the Government through Leadership in Environmental Management

17.3. REGIONAL SETTING

ARC's core businesses are astrobiology, nanotechnology, information technology, aviation systems, airspace operations, research and development, and related support operations. Resident agencies conduct a variety of activities, including research and development, airfield operations, administrative, and military support operations. As such, routine operations require the use of numerous types and quantities of hazardous materials, resulting in the generation of hazardous and nonhazardous wastes at ARC.

At any given time, there may be more than 5,000 hazardous substances in the laboratories, shops, and other facilities within the Ames Campus area, producing a comparable number of types of hazardous waste. The quantities from laboratories are often small: ounces or grams of particular substances; quantities from shops and other operations may be greater than 55 gallons.

17.3.1. REGIONAL PLUME

A plume of contaminated groundwater flows northward beneath ARC toward the San Francisco Bay. At present, the plume underlies a total of 130 hectares (320 acres) of

ARC, most of which is within the NRP area. The main contaminants in the plume are volatile organic compounds (VOCs), among them trichloroethene, 1,1,1-trichloroethane, cis- and trans- 1,2 dichloroethene, 1,1-dichloroethene, 1,1-dichloroethene, dichlorobenzene, chloroform, Freon 113, phenol, and vinyl chloride. The first two are the most commonly found (Harding Lawson Associates 2000, in Design, Community & Environment 2002).

The Regional Plume stems from two main sources: an EPA-designated Superfund site outside of ARC at the Middlefield-Ellis-Whisman (MEW) site across U.S. Highway 101, and contamination from the operation of a dry cleaning facility, a former aircraft wash rack and sump, a fueling station, and numerous underground storage tanks at Moffett Field during the Navy's administration of the base.

17.4. EXISTING SITE CONDITIONS

17.4.1. SITE CONTAMINATION

This section describes the 29 Navy contamination sites and two treatment systems, the 13 NASA contamination sites and one treatment system within the Ames Campus, and a number of other potential sources of contamination.

17.4.1.1. Navy Sites

Although control of Moffett Field was transferred from the U.S. Navy to NASA in 1994, the Navy is responsible for cleaning up any contamination from its earlier use of the base. To date, 26 potentially contaminated sites have been identified at ARC, predominantly along the western edge of the airfield and near Hangar 3, all of which pre-date NASA's administration of the property. Figure 17-1(at end of this chapter) identifies the potentially contaminated sites at ARC. Wastes from 60 years of military operations contaminated these sites. Contaminants include waste oils and fuel products, solvents and cleaning products, pesticides, paint, battery acids, and PCBs. Both EPA and RWQCB are oversight agencies for all Navy sites.

The following describes each of the 29 identified Navy sites and describes their current remediation status.

Site 1 is a former landfill, approximately 6 hectares (14 acres) in size, which was used between 1963 and 1975. The landfill received not only domestic garbage, but also waste from maintenance and military operations, including solvents, oil, paint, paint thinners, scrap metal, and sawdust contaminated with PCBs. Testing has determined that while there is no groundwater contaminant migration from this landfill, there are gas emissions, primarily methane, from decomposing garbage. This landfill has been capped with a multilayer cover as described in the Navy's Record of Decision, in accordance with its Federal Facilities Agreement and CERCLA requirements. Gas and groundwater collection trenches were dug. The trenches are sampled periodically. If leachate or gas were detected, additional remediation action would be taken.

Site 2 is a former landfill approximately 2 hectares (5 acres) in size that was operated from the 1940s through approximately 1963. This landfill is located approximately 500 meters (1,600 feet) south of Site 1, just west of the golf course. It received the same types of wastes as Site 1. The Navy, in cooperation with regulatory agencies, consolidated Site 2 into Site 1 in 1997.

Site 3 is a ditch along the eastern side of Marriage Road that is located approximately 2 meters (5 to 6 feet) below grade. Storm drains located in and near Hangars 2 and 3 discharged detergents, hydraulic fluids, oils, fuels, solvents, detergents, paint, and paint stripper into this ditch, parts of which are lined with concrete. An investigation in 1993 found no evidence of risks to human health or water quality, and the Navy, EPA, DTSC, and the San Francisco Bay RWQCB signed a No-Action Record of Decision. A relatively low level of solvent contamination was found in the aquifer below the site. The slightly contaminated groundwater is being treated aboveground using air stripping. Marriage Road Ditch has been added to Site 27 due to ecological risk from PCBs, DDT, and metals.

Site 4 is a former industrial wastewater holding pond that was unlined and received approximately 57 million liters (15 million gallons) of wastewater from airfield operations, including aircraft washing and equipment maintenance. It was removed, closed, and replaced by new ponds in the late 1970s. During the remedial investigation, no unacceptable risks to human health were identified and a No-Action Record of Decision was signed in October 1994. Risk due to exposure to beryllium in soil was identified, but beryllium concentrations were found to be naturally occurring and no remedial action was appropriate. The site is completely paved, so there are no ecological risks. No further action is planned for the site. The East Side Aquifer Treatment System is now treating groundwater contamination that may have occurred due to the ponds.

Site 5 is the main fuel facility for Moffett Field. The fuel farm site is divided into two parts: Site 5 north and south. Originally, the fuel farm consisted of 10 underground bulk storage tanks and four aboveground storage tanks. Six of the underground tanks were removed in 1995 from Site 5 south. The remaining eight tanks, four underground and four aboveground, are located in Site 5 north. These tanks are going through a closure process by the Defense Energy Supply Center (DESC). There is soil and groundwater contamination at both locations, with the heaviest contamination in Site 5 north. The Navy is currently studying the site as part of its petroleum sites evaluation and closure program to determine what remediation will be needed. There is no remediation effort currently underway at Site 5.

Site 6 is an area just north of Hangars 2 and 3 where it is believed that liquid wastes from aircraft maintenance, including paint, paint stripper, oil, fuel, and solvents, may have been dumped before it was paved in 1979.

Site 7 is an area including Hangars 2 and 3 and the unpaved and paved areas around them. Unpaved areas in the corners of each of the hangars were used to dispose of liquid wastes from aircraft maintenance, including solvents, fuel, paint, paint stripper, and hydraulic fluid. In addition, a power plant in the northeastern corner of Hangar 3 may have dumped solvents on unpaved areas around that hangar.

Site 8 is a former oil transfer area located in the northeastern portion of the Ames Campus area. From the 1940s through 1981, this area had a 19,000-liter (5,000-gallon) waste oil tank and sump, which reportedly also received transformer oils (possibly containing PCBs) and solvents. Oil spilled during transfer contaminated some soils on the site. The tank and sump were removed in 1981, and NASA remediated contaminated soils in the northern portion of Site 8 adjacent to NASA's Area of Investigation (AOI) 7 through excavation and offsite disposal in 1994.

Site 9 includes two former groups of underground fuel tanks and their associated piping. Fuel leakage from the tanks and pipes contaminated both subsurface soils and groundwater. Groundwater contamination from Site 9 mixed with the solvents in the Regional Plume, and is being remediated by the Westside Aquifer Treatment System. The Navy determined that the soil contamination met the RWQCB's requirements for low-risk closure, so no further work on the soil is planned.

Site 10 is known as Chase Park**.** No contaminant sources have been identified at this site, but the groundwater is contaminated with VOCs from the MEW site. This site is being remediated by the pump-and-treat system installed to clean up the MEW groundwater contamination plume.

Site 11 is an area near the northeastern end of the runway that was used to test aircraft engines. The site is covered with a concrete and asphalt pad, but a small drainage depression likely carried spilled hydraulic fluid, waste oil, and fuel to the southern edge of the pad.

Site 12 is the former fire-fighting training area north of Hangar 1 on the west side of the runway. Jet fuels spilled during training have contaminated subsurface soils. Most of the contaminated soils, approximately 4,200 cubic meters (5,500 cubic yards), were removed and treated in 1993. Because Zook Road and the west parallel taxiway border the site, it was not possible to remove all of the contaminated soil. The Navy evaluated the remaining contamination at Site 12 and found that it was not a threat to human or ecological receptors. No further work on the site is planned.

Site 13 is a paved area east of Hangars 2 and 3 that is used as a parking lot. A surface drainage ditch received industrial wastewater from equipment washing, leaks, and spills. The drainage ditch flows to the main storm sewer. See the description of Site 3, above, for information on current status and treatment.

Site 14 North includes two former underground tanks located near the former dry cleaning building that were removed and sampled. PCE concentrations a former Building 88 site

Site 14 South is the California Air National Guard motor pool, which is in active use. There is both soil and groundwater contamination here from two underground tanks and their piping, which have been removed. Originally, a pump-and-treat system was used to remediate the site. Low permeability soils limited flow rates, however, so this approach was abandoned. Then a remediation system involving recirculating and treating the groundwater in place was operated. Currently, the Navy is allowing the site to attenuate naturally, although benzene levels in the groundwater still exceed the cleanup level.

Site 15 includes eight sumps, one oil/water separator, and an underground storage tank. Most have been removed and the Navy is currently evaluating the site.

Site 16 includes two catch basins that drained a concrete wash pad to an underground oil/water separator. They were removed, and no contamination was found.

Site 17 is the sump for the paint shop, which received wastes including oil and latex-based paints, thinners, toluene, and turpentine. The sump and surrounding contaminated soils were removed in 1991. No contamination remains at the site.

Site 18 is the sump on the northern (down gradient) side of the former dry cleaning building. The sump was removed, and no contamination from it was found. However, the dry cleaning building, foundation, and underground piping were demolished and removed along with approximately 300 cubic meters (400 cubic yards) of soils contaminated with cleaning solvents. No further soil contamination exists, but groundwater contamination from the dry cleaning operation is being remediated as part of the Navy cleanup effort.

Site 19 includes four underground storage tanks that have been removed. One of the tanks is believed to be a source of the solvent contamination in the groundwater in the Eastside/Airfield area. The Eastern Aquifer Treatment System was addressing this contamination.

Site 20 is an area north of Hangar 1 adjacent to the airfield where off-specification fuels were stored in aboveground tanks, which were removed in 1982. Fuels spilled from these tanks and accumulated in low areas near the taxiways, runways, and Zook Road. Consequently, the soil and groundwater are contaminated with low levels of petroleum products. The Navy has determined that Site 20 meets the criteria for low-risk closure, and no further work is recommended for this site

Site 21 is a surface drainage ditch on the northern edge of the Eastside/Airfield area that carries some of the stormwater flow from the eastern side of ARC. Reportedly, waste fluids, including transmission fluid, hydraulic fluid, and motor oil, were dumped here. This site is to be further evaluated for ecological risks, along with the Marriage Road Ditch and Site 27.

Site 22 is a 120-meter (400-foot)-wide strip of landfill in the northeastern corner of the golf course lying between East Patrol and Marriage roads. The landfill was in active use from the late 1940s until the 1960s. There are no records of what was dumped at the site, but it is thought to have been primarily household waste. The Navy has installed a biotic barrier along the sides of the landfill to prevent burrowing animals from bringing up garbage from the landfill. The Navy is also monitoring the groundwater at the site.

Site 23 is a former landfill approximately 1 hectare (2 acres) in size located immediately south of the northern weapons bunker area. There is no record of the source of the material dump, but a site walkover identified construction and landscaping materials such as concrete, asphalt, grass clippings, and mulch. Aluminum airplane parts and electronic equipment were also found. There is no evidence of any hazardous materials, so no further work is planned for the site.

Site 24 includes the fuel pits in Hangar 1, the high-speed fuel facility on the east side of the base, and the fuel wharf. No petroleum contamination was found at the Hangar 1 fuel pits, though there are solvents in the underlying groundwater. Minor amounts of contamination were found at the fuel wharf and the high-speed fuel facility. The Navy is evaluating the site.

Site 25 includes the Eastern Diked Marsh and the stormwater retention pond. PCBs, pesticides, and some metals require remediation in the sediments. The Navy is proposing to excavate the contaminated portions of the site and replace them with clean material.

Site 26 includes the Eastside Aquifer Treatment System for addressing the solvent plume from Hangar 3. This is not itself a contaminated site.

Site 27 includes the Northern Channel, North Patrol Road Ditch, and Marriage Road Ditch. The principal contaminant is PCBs. The Navy has completed a proposed plan to excavate the contaminated sediments. Activities are scheduled to commence in 2006.

Site 28. The Westside Aquifer Treatment System for remediating the Navy's portion of the Regional Plume. This is not itself a contaminated site.

Site 29 is Hanger 1 and is composed of materials containing PCBs, lead, zinc, and asbestos. The Navy is currently preparing a Remedial Investigation and planning a feasibility study to address these contaminants.

17.4.1.2. NASA Areas of Investigation within the Ames Campus

NASA and its predecessor, the National Advisory Committee for Aeronautics, have conducted research at the Ames Campus since 1940. NASA has discovered 13 contaminated areas, which it refers to as AOIs, within the Ames Campus. This section describes each of the AOIs and their current remediation status.

AOI 1 is the former jet fuel depot located in the southeast corner of the Ames Campus. Four 75,000-liter (20,000-gallon) underground storage tanks were removed from the area, and NASA excavated most of the fuel-contaminated soil in April 1996. The extent of the remaining fuel-contaminated soil was roughly delineated in December 1996. In April 1999, a soil and groundwater study was conducted approximately 80 to 140 meters (250 to 450 feet) down-gradient of the former fuel farm. No soil contamination was found. A grab groundwater sample from one location contained TPHDB at a concentration of 890 g/l. The oversight agencies for AOI 1 are EPA and RWQCB.

AOI 2 is the area around Buildings N-239, N-239A, N-210, N-243, and N-243A. Well sampling results confirm that although there is an elevated level of trichloroethylene (TCE) between Buildings N-210 and N-239A, shallow soil samples taken in June 1996 in the area around the well show no solvent concentrations above the cleanup levels. AOI 2 is in the MEW area, and the MEW companies are pumping and treating groundwater in this area for chlorinated solvents. NASA has no further work planned in the area. The oversight agency for AOI 2 is EPA.

AOI 3 includes two groups of underground storage tanks in the area between and around Buildings N-248A, N-248B, and N-259 on the north side of the aircraft ramp. The tanks were known to have leaked and were removed. NASA excavated the contaminated soil in 1994 and 1995. Subsequent analyses of soil and groundwater sampled from within the eastern portion of AOI 3 and AOI 3E have detected petroleum hydrocarbons and VOCs above cleanup levels. The oversight agencies for AOI 3 and AOI 3E are EPA and RWQCB.

AOI 4 includes 12 underground storage tanks in an area on the west side of the Ames Campus that includes the National Full-Scale Aerodynamics Complex (the 40- by 80-Foot and 80- by 120-Foot wind tunnels) and the surrounding area. Several of the underground storage tanks leaked, and all have been removed. Two were replaced with double-wall tanks, which were subsequently removed. Analyses of soil and groundwater samples from within AOI 4 have detected petroleum hydrocarbons and VOCs. NASA prepared a Removal Action Work Plan for the site that has been finalized under DTSC oversight. In addition to the petroleum hydrocarbons, investigation along the southwest side of AOI 4 and in the Orion Park Military Housing area adjacent to it have shown TCE concentrations above cleanup levels that appear to be flowing onto NASA property from the upgradient housing area. NASA is currently planning to install subsurface permeable barrier technology to treat the TCE as the groundwater flows to NASA's property. The oversight agency for AOI 4 is DTSC.

AOI 5 includes two electrical substations (Buildings N-225 and N-225A), a drum storage area, and one underground storage tank located in the western portion of the Ames Campus. The drum storage area was closed in the mid-1980s, and the tank was removed in 1990. The electrical substations remain. Analyses of soil and groundwater samples from within AOI 5 have detected petroleum hydrocarbons, PCBs, and VOCs. The oversight agency for AOI 5 is DTSC.

AOI 6 is the storm drain channel and adjacent soil parallel to Lindbergh Avenue, bordered on the east by AOI 7 and by Navy Site 8. Metals, oil and grease, and PCBs were detected at this site around the channel and in the sediment in the channel. A removal action in 1994 removed most of the contaminants and Navy Site 15, Sump 64. Results from additional surface soil sampling indicate that there are low levels of contamination laterally adjacent to the former storm channel. Soil sampling had found PCB and lead levels above ecological cleanup levels. NASA completed additional remediation in October 2001. The oversight agencies for AOI 6 are EPA and RWQCB.

AOI 7 is a vertical takeoff and landing area located in the Bay View area. It is bordered to the south by a storage yard that is included in Navy Site 8. Soil and groundwater sampling have detected VOCs. Two of NASA's Regional Groundwater Remediation Program (RGRP) wells were placed in AOI 7 in 1999. The remediation system began operations in September 2001. The oversight agencies for AOI 7 are EPA and RWQCB.

AOI 8 is the Navarro farms area and includes Building N-267 and a bioremediation pad located at the northwest corner of ARC adjacent to the North of Bay View area. Analyses of soil and groundwater had detected petroleum hydrocarbons above cleanup levels. Four monitoring wells track the quality of the groundwater. Source removal has been completed. The oversight agency for AOI 8 is DTSC.

AOI 9 is an area on the east side of the Ames Campus, including Buildings N-244 and N-245, the soccer field, and a childcare center. No underground storage tanks are known to exist within AOI 9. Despite this, analyses of soil and groundwater samples have detected petroleum hydrocarbons and solvents, apparently originating from AOI 3, which is located immediately to the southwest of AOI 9, or from former localized waste dumping practices. Two of NASA's RGRP extraction wells were placed in AOI 9 in 1999. The remediation system began operations in September 2001. The oversight agencies for AOI 9 are EPA and RWQCB.

AOI 10 includes the three electrical substations that are not located in any of the other AOIs. Transformer oil containing PCBs was used historically in many of the transformers in the Ames Campus. PCBs were detected above the restricted area cleanup level in one soil sample from the Building N-221C Substation. Total extractable petroleum hydrocarbons were detected above the petroleum hydrocarbon cleanup level in one soil sample from the Building N-227 Unitary Substation. NASA has proposed in-situ bioremediation of fuel-contaminated soils at the Building N-227 Unitary Substation. Excavation of PCB-contaminated soils at the Building N-221C Substation has been completed. The oversight agency for AOI 10 is DTSC.

AOI 11 includes 14 existing or former underground storage tanks at nine sites not located in other AOIs. All of these tanks have been removed. One (Tank 7) was replaced with a double-wall tank, which was subsequently removed. All of the three former single-wall tanks at the Building N-251 motor pool were replaced with two double-wall tanks. Contamination remains at Tank Sites 7 and U-14. New Tanks 25 and 26 (Motor Pool) are still in use. The remaining tank sites are now clean. The oversight agency for AOI 11 is DTSC.

AOI 12 is the area around Building N-211, the aircraft hangar. Petroleum hydrocarbons are present in a groundwater monitoring well to the east of the hangar, either from two former underground storage tanks or from an unknown upgradient source. The oversight agencies for AOI 12 are EPA and RWQCB.

AOI 13 includes the wetlands north of and within the North of Bay View area, including the Eastern Diked Marsh, and the Storm Water Retention Pond. This is the same as Navy Site 25. The primary contaminants in these areas are PCBs, DDT, lead, and zinc. The Navy is the lead for site investigation and remediation. NASA has also contributed to contamination in AOI 13. The oversight agencies for AOI 13 are EPA and RWQCB. NASA is also complying with the relevant requirements of the U.S. Fish and Wildlife Service and California Department of Fish and Game.

17.4.1.3. Other Potential Sources of Contamination

This section summarizes known information regarding storage tanks, lead-based paint, asbestos, PCBs, spent abrasive materials, radon, mold, medical/biohazardous waste, and pesticides at ARC.

Storage Tanks

Several hundred underground storage tanks have been present at ARC; most of them have been removed. The removed tanks are in various stages of the closure and/or remedial investigation process. Many of the aboveground storage tanks, sumps, and oil/water separators were also removed. Tanks that were still needed and in compliance were kept, while others were replaced with double-wall tanks.

Lead-Based Paint

Many of the buildings at ARC have been surveyed for lead-based paint. Because lead-based paint was in common use before 1978, it is assumed that the majority of the buildings at ARC contain it. Sampling has also found lead contamination in the soils surrounding some of the buildings that had lead-based exterior paint (Professional Analysis, Inc. 2001).

Asbestos

As with lead-based paint, most of the buildings at ARC have been tested for asbestos-containing materials (ACMs). ACMs were in common use into the 1970s and were found in almost all of the buildings tested. Common ACMs at ARC include pipe lagging, floor and ceiling tile, sheetrock, waterlines, and gasket material.

Polychlorinated Biphenyls

There is a substantial amount of documentation of the presence of PCBs at ARC, including a base-wide inventory conducted by the Navy prior to handover, and quarterly inspections still being carried out by the NASA Environmental Services Office in compliance with 40 CFR 761. Known items containing PCBs include capacitors, regulators, oil fuse cutouts, oil circuit breakers, oil switches, transformers, and fluorescent light ballasts. Many of the known pieces of equipment with PCBs have already been removed and disposed.

Four PCB transformers at Moffett Field were removed during 1999; an additional PCB transformer was scheduled for removal in 2000. In September 1999, a PCB Transformer, T-84, was removed from the northwest corner of Building N-237. An area of concrete 3 meters long by 2 meters wide by 20 centimeters thick (10 feet long by 6.5 feet wide by 8 inches thick) and with approximately 0.75 cubic yards (2 inches) of soil underlying the concrete was removed and disposed. Three soil samples were collected and analyzed for PCBs. The results were less than 1 part per million (ppm), 16 ppm, and 1.5 ppm for the soil samples. The site qualifies as a “low occupancy area” under 40 CFR Part 761, and all results of the soil sampled under the concrete were 25 ppm or less.

In 2003, Hangar 1 was found to be a source of PCBs, as well as containing lead, asbestos, and zinc. NASA notified EPA and closed the hangar to the public. NASA removed the contaminated sediment from the storm drain trench around the hangar, and the Navy conducted a short-term mitigation known as a Time Critical Removal Action (TCRA) to protect human health and the environment. The TCRA included coating the hangar with an asphaltic emulsion to prevent discharge of PCBs to the storm drain system and fencing in the hangar area to prevent human exposure by controlling access to the hangar. Hanger 1 is now the Navy Site 29.

Known PCB-containing equipment at ARC is either in service, in storage, or has been disposed (Table 17-1). ARC’s 2003 annual document log reported 19 PCB transformers (containing >500 ppm PCBs), 23 PCB-contaminated transformers (containing 50-499 ppm PCBs), and 4,420 PCB capacitors (containing >500 ppm PCBs) on site.

Table 17-1 Weight of PCB (kilograms) in PCB-Containing Equipment at NASA Ames, 1995–1998

PCB-Containing Equipment Status	1995	1996	1997	1998
In service	78,924	70,497.7	66,851.1	91,635
In storage	4,769	0	2453	1,632.9
Disposed	35,767	23,490.5	11,233.5	17,651.5

In 2001, sampling conducted by NASA at the Bay View Area found no PCBs. Low concentrations of metals and pesticides were found. There are two known contamination sites south of the Bay View area at the down gradient end of the offsite Orion Park plume, AOI 5 and AOI 11. NASA is working on the Removal Action Workplans for these two sites.

Mold

Different mold varieties can cause a range of illnesses, including infectious diseases, allergies, and dermatitis. Mold has been detected in various buildings within ARC. NASA has issued guidelines with precautions for entering these buildings.

Pesticides

Currently, NASA uses the herbicides Round-up, Rodeo, Direx 4L, Surflan, and Turflon, and the pesticides Gas cartridges, Maxforce gran, Tempo dust, Avert, Terro ant bait, Dragnet, and BP 100. A number of other pesticides were used at Moffett Field in the past, and there is a potential for residual levels of chemicals in soil. In particular, the pesticide dieldrin has been found in surface soil samples in the Bay View area in concentrations above residential risk-based screening levels.

Tables 17-2 and 17-3 identify annual quantities of the herbicides, insecticides, and pesticides used on site, as well as the purpose, method of application, and annual quantity used. Pesticide and herbicide use is confined primarily to the developed portions of the site. The Santa Clara County Vector Control addresses Mosquito abatement.

Table 17-2 Herbicide Usage at NASA Ames

Chemical	Purpose	Amount Used (lbs/kg)
Round-up	Post-emergent weed control	181/82
Rodeo	Post-emergent aquatic weed control	12/5
Direx 4L	Post-emergent weed control	496/225
Surflan	Pre-emergent weed control	49/22
Turflon	Ester herbicide	86/39
Herbicide usage between January 1 and December 31, 1998 lbs/kg = pounds per kilogram		

Table 17-3 Pesticide Usage at NASA Ames

Chemical/Devices	Purpose	Amount Used (lbs/kg)
Gas cartridges	Gopher and ground squirrel control	40 each
Maxforce gran	Ants and cockroach control	90/41
Tempo dust	Ants, roaches, spiders, gnats, and fleas	0.75/0.34
Avert	Cockroach control	0.28/0.125
Terro ant bait	Ant control	13/6
Dragnet	Flea control	0.25/0.11
BP 100	Cockroaches and spiders	0.75/0.34
Pesticide usage between January 1 and December 31, 1998 lbs/kg = pounds per kilogram		

A licensed contractor is responsible for the storage and application of pesticides, herbicides, and insecticides. Chemicals are not stored on site. Materials are mixed off site and brought to ARC in a diluted form for application. All herbicides are applied by hydraulic or backpack sprayer. Surplus materials are removed from ARC.

Onizuka Air Station is responsible for landscape maintenance of the ARC golf course. Prior to application of any chemicals, ARC's maintenance staff posts warning signs in the area and notifies nearby occupants. Coordination of activities ensures that potential adverse health effects on humans and the environment are avoided.

Radiation

Sources of radiation at ARC are classified as major or minor (Table 17-4). Major ionizing radiation sources are few in number. Minor sources are dispersed throughout the site and used principally for discrete research projects.

Table 17-4 Sources of Radiation at NASA Ames

Ionizing Radiation	Potential Population Exposed	Source	Regulatory Reference
Radioactive materials	200	Laboratory Radionuclides Buildings 19, N-236, N-239, N-261, N-240, and N-218MM	10 CFR 20, Safety Review of new operations
Radioactive materials	100	Industrial Radiographies (Iridium 192) centerwide	10 CFR 34, Safety review of new operations
Radioactive materials	5	Moisture density gauge (cesium/americium) centerwide	10 CFR 20, Safety review of new operations
Radiation machines	40	X-ray machines, Electron microscopes Buildings N-234, N-236, N-237, N-239, N-240, N-244, and Hangar 3	CCR Title 17, Safety review of new operations
Nonionizing Radiation	Potential Population Exposed	Source	Control Technique
Radar	20	Radar transmitters/Receivers centerwide	Safety review of new operations, NASA AHB 1700.1, Chapter 8
Microwaves	50	Microwave transmitters centerwide	Safety review of new operations, NASA AHB 1700.1, Chapter 8
Ultraviolet	40	Ultraviolet lamps	Safety review of new operations, NASA AHB 1700.1, Chapter 8
Infrared and visible spectrum	250	Lasers (total of about 100) at various fixed and temporary locations throughout center	Safety review of new operations, NASA AHB 1700.1, Chapter 8
Source: SAIC 1996.			

Sources of ionizing radiation at the site include numerous sealed and unsealed sources of radioactive materials in laboratory use, a moisture density gauge equipment calibrator, and a variety of X-ray-generating machines used for research. The primary radioactive isotopes used at ARC in laboratory experiments are carbon-14 and tritium (3H). Large industrial sources of iridium are used for industrial radiography, and a cesium source is used for calibration. The quantities of radionuclide in use generally are expressed in microcuries (μCi) or millicuries (mCi).

Sources of nonionizing radiation at the site include lasers, microwave, radio frequency transmitters, and ultraviolet (UV) radiation (ultraviolet lamps) used for research and routine uses. Much of the research use includes Class IIIb and Class IV lasers. The lasers are used in laboratories, wind tunnels, on the runways, and on experimental aircraft. Microwave and radar units are maintained by the military at Moffett Federal Airfield. A small group of researchers is investigating the biological and physical properties of UV radiation. There are numerous sources at ARC of Extremely Low Frequency (ELF) and Ultra Low Frequency (ULF) radiation, which have not been shown to be harmful. The Non-Ionizing Radiation Safety Committee and the Radiation Safety Committee provide oversight for the safe use of these radiation sources. Radioactive waste is stored in a decay-in-storage facility licensed by the Nuclear Regulatory Commission (NRC). A commercial radioactive waste broker removes radioactive waste materials not maintained for decay or containing Resource Conservation and Recovery Act (RCRA)-controlled materials from the site to be disposed of off site at licensed facilities.

Other Potential Sources

Some medical or biohazardous waste has been and is generated within ARC. At present, very small quantities of medical and biohazardous wastes are generated in three locations at the center due to research activities and the operation of the center's Health Unit. There are a few locations, such as the wind tunnels, where uncontrolled blasting could have occurred at ARC. Testing has not found any radon levels above the EPA's action levels (Harding Lawson Associations 2001, in Design, Community & Environment 2002).

17.4.2. ADJACENT OFF-SITE CONTAMINATION

During the investigation and monitoring activities for NASA AOIs 4 and 11, low levels of TCE were discovered in the groundwater in Orion Park. In order to locate the source of TCE, NASA conducted several investigations. A review of well data and subsurface geology indicates that the TCE is coming from the offsite housing area, and then flowing beneath the western portion of the Ames Campus. The U.S. Navy is planning to continue with the investigation of Orion Park in order to determine the source of the TCE. NASA is also conducting further investigation of the area to better define subsurface conditions with the goal of implementing some control measures to prevent further migration of TCE onto the Ames Campus and to prevent its migration beneath Bay View. Potential hazardous materials contamination may also exist in the nearby Mountain View industrial area, where some hazardous materials users operate.

17.4.3. ENVIRONMENTAL MEASURES

NASA and ARC have identified the following environmental measures that are designed to address potential hazardous materials effects of operations and future development at ARC and are implemented to the extent feasible.

17.4.4. HAZARDOUS MATERIALS AND WASTES

A number of protocols are in place throughout ARC to control the hazards associated with hazardous substances and to minimize the risks of exposure or spills. The *Ames*

Environmental Procedural Requirements ensure that the center meets all federal, state, and local hazardous materials and hazardous waste regulations. The *Hazardous Waste Minimization Plan* prescribes actions that will reduce ARC's hazardous waste output.

Container management rules intend to decrease the impacts of hazardous materials. Container management general rules include:

- Limit storage to a 1-week supply, if feasible
- Return containers to storage location daily
- Keep containers tightly closed when not in use
- Do not remove or deface manufacturers' labels
- Label all containers to meet Hazard Communication or Lab Standard requirements
- Store corrosives below shoulder height
- Store poisons separately in a controlled area
- Store flammable liquids (> 10 gallons) in vented cabinets
- Store refrigerated flammables in a desparked refrigerator
- Segregate chemically incompatible materials
- Observe special rules for flammable and toxic gases
- Secondary containment for stored liquids, liquids in use, and hazardous solids

Detailed procedures for managing hazardous materials are found in Chapter 3 of the Ames Environmental Management Handbook.

In addition, NASA implements internal policies and procedures to prevent accidental releases of toxic gas by users. The quantities of toxic gases stored on site are limited and monitored quarterly to minimize impacts from an accidental release of toxic gas at ARC.

□NASA's *Hazardous Materials Management Program* identifies sources of information on hazardous materials. The plan includes avenues for employees to choose the least hazardous material, minimize quantities of hazardous materials used, minimize the sources of hazardous waste, plan for appropriate storage, and plan for controls (including engineering (ventilation, and sensors), administrative (procedures), and personal protective equipment).

Various hazardous materials are used at ARC in research projects and day-to-day operations. It is a requirement for all ARC employees who handle hazardous waste to be trained in hazardous waste management, release response, and environmental essentials. Hazardous materials users are required to prepare accurate hazardous materials inventory statements (HMIS). Each HMIS includes the location, type, and amount of hazardous materials and associated hazards. ARC prepares a centerwide HMIS annually; the centerwide HMIS is submitted to Santa Clara County's Hazardous Materials Compliance Division.

Each hazardous materials storage area is inspected regularly to ensure that all containers are in good condition and that secondary containment systems are free of liquid. Discrepancies are promptly corrected. ARC has implemented procedures for managing hazardous materials. These procedures are found in Chapter 3 of the Ames' *Environmental Management Handbook*. All civil servants, contractor employees, and resident agency personnel at ARC who use, store, or manage hazardous materials are required to follow these procedures.

Toxic gases are used in various research projects and in day-to-day operations. These gases are typically contained in small lecture bottles and cylinders and must be stored in appropriate cabinets and controlled areas.

To minimize potential community impacts, a policy was implemented at ARC in spring 1997 that limits the quantity of toxic gas that can normally be used or stored on site. Toxic gas users that may require larger quantities would be required to prepare an offsite consequence analysis, in accordance with EPA and other applicable protocols, to determine the potential for impacting nearby communities during a worst-case release of toxic gas. ARC monitors the amount of toxic gas kept on site by completing quarterly inventories that document the type, location, and amount of toxic gas on site.

The Radiation Safety Committee supervises and monitors all activities at ARC that might involve radiation hazards. The Ames' Radiation Safety Committee is composed of the Radiation Safety Officer and members of the ARC scientific community experienced in the handling and safeguarding of radiation sources and radioactive materials. The Ionizing Radiation Committee authorizes use, prepares hazard analyses, establishes safety practices, and approves facilities in which radiation sources will be used, and generally supervises and monitors all ARC activities in which radiation hazards may be a factor.

The Radiation Safety Officer, appointed by Ames' Director with the concurrence of the NRC, works with the Ames' Occupational Safety, Health, and Medical Services Office performing day-to-day radiation safety oversight. Radiation Safety Officer activities include training, maintaining controls of radioactive materials possession, experimental design, operation of ionizing radiation sources, administration of the NRC license audit, and measurement of all radionuclide-producing electronic emission devices. All ionizing radiation sources greater than NRC defined "generally licensed materials" are licensed or registered, depending on their use.

The Non-Ionizing Radiation Safety Committee oversees the use of nonionizing sources of radiation at the site. The Non-Ionizing Radiation Safety Committee is composed of the Laser Safety Officer and members of the ARC scientific community having experience in the handling and controls of nonionizing sources of radiation. The Non-Ionizing Radiation Committee authorizes use, prepares hazard analyses, establishes safety practices, and approves facilities in which radiation sources will be used, and generally supervises and monitors all ARC activities in which laser hazards may be a factor.

The Laser Safety Officer, appointed by the ARC Director with the concurrence of the NRC, works with the Ames' Occupational Safety, Health, and Medical Services Office performing day-to-day laser safety oversight. Laser Safety Officer activities include training, evaluations of new sources, assistance in experimental design, checks for proper operation, internal audits, and operations safety procedures.

The *Hazardous Substance Reporting Protocols* set procedures for reporting hazardous substances to outside regulatory agencies, which is done by the NASA Ames Environmental Services Office. Other personnel report hazardous substance inventory to the NASA Ames Environmental Services Office, and report hazardous substance spills to the NASA Ames Duty Office, which activates the spill response system.

The *Hazardous Waste Disposal Procedures* at ARC require that all hazardous wastes be transported to secure, ventilated packaging areas, from which they are packaged and transported to state and federally authorized treatment or disposal sites.

The *PCBs Removal and Controlling Access Policy* is stated in the Ames Environmental Management Handbook (APR 8800.3), Chapter 9, Polychlorinated Biphenyl Management. PCB management requirements at ARC include quarterly inspections, training, reporting and recordkeeping, spill cleanup and reporting, safe storage, transportation, and disposal. ARC implements ongoing efforts to remove PCB-containing equipment and light ballasts per regulatory compliance and through the replacement of obsolete items.

The *Radioactive Waste Disposal Procedures* require that all radioactive wastes be stored in a bunker near Building N-218. Approximately every 3 months, a licensed contractor removes the waste from the bunker and takes it to authorized disposal sites within the United States. NASA is authorized to hold radioactive material with a physical half-life of less than 120 days for decay-in-storage before disposal. ARC is licensed by NRC to possess and use radioactive materials. The Radioactive Materials License, 04-07845-04, is administered under supervision of the Ames Radiation Safety Committee.

Chapter 7 of the Ames *Health and Safety Manual*, APR 1700.1; Titles 10, 21, and 49 of the CFR; and Title 17 of the CCR provide the controls and procedures used to regulate ionizing sources of radiation. Chapter 8 of the Ames *Health and Safety Manual*, ANSI

Z136.1, and 29 CFR (Occupational Safety and Health Administration section) provide the controls and procedures used to regulate nonionizing sources of radiation.

17.4.5. POLLUTION PREVENTION

ARC is in the process of implementing NASA's Environmental Excellence for the 21st Century strategy, which includes a pollution prevention plan consistent with the requirements of relevant federal and state regulations and laws. Pollution prevention refers to technology or operational changes that reduce the amount and/or toxicity of hazardous materials used and waste generated. Examples of pollution prevention practices include source reduction (through product substitution and source control), employee and management training in environmental best management practices, product redesign and process modification, reuse and recycling of materials, and treatment/disposal of wastes.

ARC has reduced solid and hazardous waste production, minimized impacts to the environment, and controlled air emissions through a variety of methods and technologies. In addition, ARC has routinely implemented recycling and educational programs to reach the ARC community and bring environmental issues to the forefront. In accordance with Executive Orders 13101, 13148, 13149, and 13150, ARC's goal is to increase waste prevention, recycling, and the purchase and use of recycled content and environmentally preferable products and services. The following are some of the pollution prevention programs and activities that are currently being implemented at ARC. ARC implements NASA's pollution prevention strategy by:

- Operating the Ames Chemical Exchange (ACE)
- Maintaining accurate and up-to-date Building Emergency Action Plans (BEAPs) and Spill Prevention Control and Countermeasures (SPCC) plans and ensuring that facility activities comply with the procedures within these plans
- Reviewing and revising standard construction specifications to incorporate pollution prevention measures into all phases of a project and inspecting major construction projects to ensure compliance
- Supporting and continually improving facility-wide recycling efforts
- Promoting employee awareness of environmental programs through training and active information dissemination
- Reducing the use and storage of hazardous materials through materials substitutions and more efficient procurement strategies
- Promoting affirmative procurement of recycled goods and services
- Identifying measures to reduce major hazardous waste streams

17.4.5.1. Composting and Soil Bioremediation

All landscaping green waste is composted or made into mulch in an area south of Outdoor Aeronautic Research facility for future landscaping use. A composting program began in 1996 at ARC. At its inception, the program consisted of gathering yard waste from the ARC golf course and composting it into green material active compost. During 1997, the program was extensively modified to include all landscape trimmings generated at ARC, and a limited amount of shredded paper. In addition, during scheduled periods, such as Pollution Prevention Week, employees are educated in the composting process and a composting open house is held at the composting facility. This program has several benefits. It dramatically reduces the volume of material sent to landfills, saves money spent on landscape maintenance by reducing the purchase of soil amendments, and provides an educational opportunity for the ARC community.

Bioremediation is the use of microbes to degrade or transform chemicals and compounds into simpler, more desirable, less harmful, or less toxic substances. Bioremediation activities were initiated in late 1994. A treatment pad was designed and built to treat soil contaminated with petroleum hydrocarbons such as diesel fuel efficiently, while at the same time protecting the surrounding environment. Soils with fuel levels of 1,000 ppm or less from various excavation locations throughout ARC are brought to the remediation pad for treatment.

Contaminated soil is windrowed (piled in long rows) on the remediation pad. Green material compost, mentioned above, is then added as a soil amendment to increase soil permeability, oxygen transfer, improve soil texture, and provide an energy source for the rapid establishment of a large microbial population. The soil microbes consume both the compost and the petroleum product.

The soil is periodically mechanically agitated with mixers to redistribute the material, break up any stratification induced by biological action, and to reduce the size of particles for ease of handling. Treatment is concluded when a cleanup level of 400 ppm or less for high boiling point (BP) or 150 ppm for low BP fuels is obtained. Discrete samples are collected for every 20 cubic yards of soil, for verification of fuel's total petroleum hydrocarbons levels. Successfully treated soil is used as backfill at various locations at ARC, dramatically reducing the amount of material sent out for disposal, as well as reducing the need to import clean fill.

17.4.5.2. Recycling and Source Reduction.

Some of the items ARC is currently recycling include white paper, mixed paper, cardboard, toner cartridges, various types of batteries, fluorescent lamps, certain solvents, waste oil, oil filters, scrap metal, tires, computers, construction and demolition waste, empty drums, and plastic, glass, and glass containers. The motor pool currently recycles coolant, oil filters, and oils, and uses recycled oil. In addition, retread tires are used when possible.

To minimize the amount of waste generated, ARC is dedicated to recycling used materials when possible. Reporting the quantities of recycled material is required for the following purposes:

- EPA biennial reporting for hazardous waste generators
- Annual recycling update questionnaire submitted to NASA headquarters
- Tracking progress toward established solid waste recycling goals
- Tracking progress toward hazardous waste minimization goals
- Tracking progress toward pollution prevention goals

17.4.5.3. Electronic Waste Recycling

Ames owned computers and equipment that are surplus are managed by the property disposal office, Code JFS. Ames computers that are turned in to the property disposal officer are staged in the N-255 warehouse for the required screening period. During this screening period, anyone at Ames or any other federal or state agency can claim the computer for internal government use. Equipment that is not reutilized during the screening period is donated to schools or educational institutions under the Computers for Learning program run by GSA. Equipment that is not donated or reutilized is sent to an approved processing facility for materials recovery within North America. The Ames Environmental Office, Code QE, audits and approves the facility to ensure that the equipment is handled properly and that no e-waste is exported to overseas scrap markets, either directly or through recycling brokers.

17.4.5.4. Affirmative Procurement

ARC continues to promote affirmative procurement and uses recycled products whenever possible as the default items procured through Stores Stock, in accordance with RCRA Comprehensive Procurement Guidelines and EO 13101.

The following practices are incorporated into all ARC activities and operations to promote cost-effective source reduction and to enhance recycling.

- Recycled Products Purchasing - When purchasing/ordering items designated by EPA as being available with recycled content, all ARC employees and contractors shall purchase those items composed of the highest percentage of recovered materials practicable consistent with product performance requirements, quality, and safety.

- Recycled Paper Use - All employees shall order and use printing and writing paper made from recycled materials instead of products made from virgin materials. Printing and writing paper ordered shall contain at least 100% recycled fibers (paper meeting the 50% recycled content requirement is currently available from onsite Stores Stock).
- Double-Sided Photocopies - Reports, memos, and other paper documents shall be photocopied in double-sided format when possible.
- Electronic Communication - Employees shall transfer documents electronically when possible.
- Energy Conservation - All employees shall turn off computers, lighting, printers, and other equipment when not in use and prior to leaving for the day, when feasible.
- Reusable Products - All employees shall order and use non-disposable products or products that promote reuse (for example, ballpoint pens with replaceable ink cartridges and rechargeable batteries).

17.4.5.5. Energy.

ARC reduces energy use whenever possible through a combination of alternative source of energy projects, relamping initiatives, centerwide e-mails, and use of the Energy Saving Program Contract (ESPC). New facilities and equipment shall include specifications for conserving water and energy. Examples include energy-saving lighting devices and cooling towers use treated and recycle water.

17.4.5.6. Chemicals and Ozone-Depleting Substances

Unused chemicals that are in good and stable condition are reused on site through the Ames Chemical Exchange (ACE) program. The ACE is a chemical redistribution program that promotes the use of surplus chemicals. By using ACE, individuals and organizations save money by eliminating the purchase of new chemicals and reducing or eliminating disposal costs of surplus chemicals.

It is the responsibility of chemical purchasers to check the ACE inventory for product availability prior to purchasing new chemicals. This can be done via the Internet or with the assistance of the Ames' Pollution Prevention Coordinator. Every attempt is made to provide the ARC community with alternatives to the purchase of new chemicals.

All chemicals on site are tracked through a Hazardous Materials Inventory System (HMIS) to ensure safety and possible source reduction. Ozone-depleting substances (ODS) continue to be reduced and eliminated whenever possible through process modifications and chemical substitutions.

ARC operates a chemical redistribution program designed to promote use of excess, unused, or unwanted chemicals by center personnel. Some excess chemicals are also reused/recycled offsite. ARC has targeted four chemicals for reduction (Table 17-5).

Table 17-5 Hazardous Materials Release Reductions

Chemical Name	Annual Releases in 1994 (base year)	Annual Releases in 1998	% Reduction
CFC-12	2,400 lbs.	0 lbs.	100%
CFC-113	800 lbs.	0 lbs.	100%
Hydrazine	300 lbs.	0 lbs.	100%
Xylene	243 lbs.	37 lbs.	85%
Source: NASA 1997b.			

In 2003, ARC generated 3,400 tons of solid waste, which includes recycled waste. The agency goal is to Divert 35% of solid waste away from landfills by CY 2010 compared with CY 1997, the baseline year. In March 2002, ARC submitted a Pollution Prevention Plan to NASA Headquarters that included a commitment to help the agency achieve a diversion rate goal 35% by 2010. As of 2003, ARC's waste diversion rate is 49%. In 2003, ARC's recycling and yard waste composting programs diverted 1,691 tons of material from the landfills. Table 17-6 shows the breakdown of materials recycled and reused in 2003.

Table 17-6 Materials Recycled and Reused In 2003

Material Recycled (2003)	Tons
Construction/Demo	63.4
Computer monitors	1.6
Computer equipment (JFS)	6.4
Metal scrap	387.7
Paper	175.9
Cardboard	52.5
Toner cartridges*	2.3
Plastic	0.0
Glass	0.5
Al cans	0.1
Wood scrap	29.2
Landscape debris	970.2
Tires	1.3

The landscape debris, or green waste, is collected from on-site grounds maintenance operations delivered to the on-site composting yard that is operated by the Plant Engineering organization. The program, which began in 1996, incorporates lawn clippings from the Moffett Golf Course and takes in approximately 5,000 cubic yards of green waste per year. The finished mulch product is stockpiled and used on-site in planting areas to help control weed growth.

The toxic chemical release inventory (TRI) reduction goal for the agency is a 40% reduction in releases of TRI chemicals by 2006 as compared to the baseline year of 2001. The previous baseline year was 1994. Ames TRI reduction progress through 2003 is shown in Table 17-7.

Table 17-7 Toxic Chemical Release Reductions Progress

	Baseline			
Chemical	**1994**	**2001**	**2002**	**2003**
R-113 or CFC-113 (trichlorotrifluoroethane)	1300	174	0	0
R-12 CFC-12 (dichlorodifluoromethane)	2400	15	0	0
R-22 or HCFC-22 (chlorodifluoromethane)	0	694	1113	410
Ethylbenzene	0	5	28	21
Toluene	0	272	147	257
Xylene	0	255	193	214
Totals	3700	1415	1481	902
Goal		849	849	849
% Reduction		N/A	-5%	36%
Goal: 40% reduction by 2006 compared to 2001 baseline				

17.4.5.7. Integrated Pest and Vegetative Management.

The impact of pesticide use on biotic resources on site is minimal because ARC applies Integrated Pest Management (IPM) and Integrated Vegetation Management (IVM)), which are complementary programs that employ methods designed to reduce impacts to the environment.

Under the guidance of the Bio-Integral Resource Center, a research/educational organization specializing in IPM, the ARC IPM team was initiated in 1997 with a pilot project in six buildings. In 1998, IPM was expanded to include all buildings at ARC. IPM techniques replace traditional reactive pesticide applications with a monitoring and management approach that focuses on long-term pest prevention and reduced use of toxic substances.

IPM activities include designing a monitoring and recordkeeping system, testing treatment methods, improving building sanitation and pest proofing, training pest management staff, and educating building managers and occupants on IPM activities. The program replaces routine spraying of liquid pesticide formulations around buildings with a strategic placing of least-toxic, low-dose bait stations to control cockroaches, Argentine ants, and mice. Other IPM methods include use of least-toxic easily biodegradable pesticides, and use of visual barriers and habitat changes to contain ground squirrels.

Beginning in 1998, the IVM program began to expand. The use of goats for control of "stubborn vegetation" and the use of native plant species are two elements of the program. Other aspects of the IVM program include turf and field mowing adjustments (in which the timing of and height of cutting helps eliminate undesirable plant species) and use of least-toxic herbicides that are easily biodegradable. The IVM program is still developing, and alternative procedures for vegetation management are currently being explored for inclusion into the IVM program.

Prior to implementation of IPM and IVM, pesticide and herbicide application totaled 4,000 gallons. In 1998, combined pesticide and herbicide used dropped to 116 gallons, a 97% reduction since the inception of the IPM and IVM programs.

17.4.5.8. Training and Awareness.

Training and outreach programs run throughout the year. Some of these activities include seminars, centerwide e-mails, America Recycles Day, Earth Day, Pollution Prevention Week, organization-specific training, and a general Hazardous Waste and Environmental Essentials training course.

17.4.5.9. NASA Ames Pollution Prevention and Sustainability Award Program

The ARC Pollution Prevention and Sustainability Award Program is designed to solicit the creativity of all employees in developing techniques or operational changes that will reduce pollution and other impacts of ARC's operations on the environment. Employees have received awards for IPM, landscape composting, development of an environmentally friendly aircraft de-icing compound, and initiation of a centralized hazardous materials system that reduces use/storage of hazardous materials for a research organization. Employees working directly with hazardous materials or with the waste generating process are best suited for finding ways to reduce hazardous materials use and waste generation. Waste reduction can be achieved through various methods, including simple procedural changes in routine operations, substitution of products with less toxic alternatives, and installation of systems that treat and recycle chemical materials that would otherwise require disposal.

The award program provides recognition for employees to develop and implement pollution prevention initiatives during their daily operations and activities at ARC. Individuals or groups who contribute significantly to environmental protection and pollution prevention can receive an award as recognition for their efforts. An eligible contribution must produce a reduction in disposal costs, in volume of waste requiring disposal, in the toxicity of the waste generated, or produce a significant environmental benefit.

17.4.5.10. Industrial Wastewater Treatment Facility

ARC operates a facility that treats industrial wastewater through microfiltration and reverse osmosis in order to recycle water for use in selected research operations, and to reduce the concentration of copper and other heavy metals in effluent discharged to the sanitary sewer.

17.4.5.11. Cleanup of Regional Plume

EPA and the companies responsible for the MEW contamination signed a Record of Decision in 1989 that included an agreement on how and to what level the MEW Superfund site would be remediated. EPA later determined that the cleanup of groundwater and soils at Moffett Field contaminated by the MEW plume was subject to the MEW Record of Decision.

The Navy and the MEW companies are thus jointly conducting remediation under EPA supervision, with periodic monitoring to evaluate the progress of remediation efforts. As of 1997, both the Navy and the MEW companies had designed and installed coordinated permanent remediation systems. NASA has also contributed contamination in the northern portion of the plume. In response, NASA has installed a remediation system that started operation in September 2001. EPA and the California RWQCB are the oversight agencies for cleanup of the Regional Plume. Sampling has been conducted to determine whether of contaminant volatilization in the plume is contaminating soils or indoor air quality. The results of this sampling are discussed in Chapter 8, Air Quality.

17.4.6. Mitigation Measures

The NASA Ames Development Plan (NADP) Final Programmatic Environmental Impact Statement (FEIS) identified mitigation measures to address potential hazardous materials impacts from build out of Mitigated Alternative 5 in the NADP (Design, Community & Environment 2002). For a full discussion of impacts and mitigation measures related to the NADP, see the FEIS

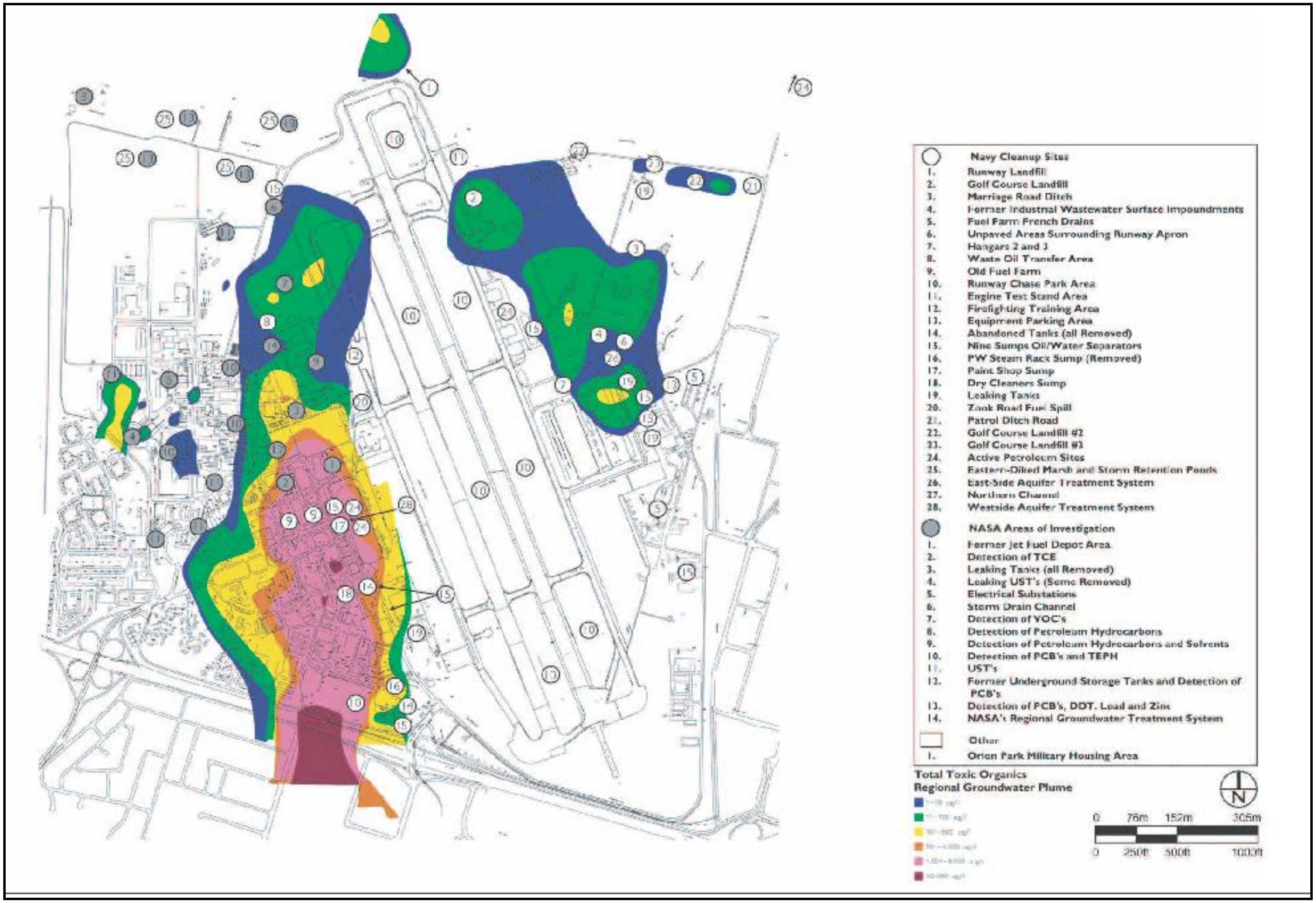

Figure 17-1 Hazardous Materials Sites and Plumes

Chapter 18. Environmental Justice

18.1. OVERVIEW

This chapter presents a discussion of race and income statistics for areas surrounding ARC. It also summarizes the regulations relevant to environmental justice as well as NASA Supporting Policies and Procedures. *Environmental justice* is the principle that low-income populations and minority populations should not disproportionately bear the burden of environmental hazards. Some information and data presented in the following sections was obtained from the NASA Ames Development Plan Final Programmatic Environmental Impact Statement (Design, Community & Environment 2002).

- 18.2.1, Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations
- 18.2.3.2, NASA's Environmental Justice Implementation Plans
- 18.3.1, Minority Populations (2000 census data)
- 18.3.2, Low-Income Populations (2000 census data)

In this chapter, a *minority* is defined as "individual(s) classified by Office of Management and Budget Directive No. 15 as Black/African American, Hispanic, Asian and Pacific Islander, American Indian, Eskimo, Aleut, and other non-white persons" (Interagency Working Group on Environmental Justice (IWG) 1995; EPA 1997). According to the IWG (1995), *minority populations* "should be identified where either: (a) the minority population of the affected area exceeds 50 percent, or (b) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis."

Low-income populations may be identified by either the Department of Health and Human Services poverty guidelines or the Department of Housing and Urban Development (HUD) statutory definition for very low income for the purposes of housing benefits programs (IWG 1995).

NASA has reviewed 1990 and 2000 census data compiled by the U.S. Census Bureau and has identified minority and low-income communities in census tracts within the cities of Mountain View and Sunnyvale (Figure 18-1). To remain consistent, NASA uses the definitions of *minority community* and *low-income community* that are used by the cities of Mountain View and Sunnyvale.

18.2. REGULATORY REQUIREMENTS

This section discusses federal regulations affecting NASA, as well as policies and procedures developed by NASA.

18.2.1. EXECUTIVE ORDER 12898, FEDERAL ACTIONS TO ADDRESS ENVIRONMENTAL JUSTICE IN MINORITY POPULATIONS AND LOW-INCOME POPULATIONS

On February 11, 1994, the President of the United States issued an Executive Order on Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations (Executive Order 12898). The order is designed to focus federal attention on the environmental and human health conditions in minority and low-income communities with the goal of achieving environmental justice. The order directs federal agencies to:

- Develop strategies that promote non-discrimination in federal programs that substantially affect human health and the environment
- Provide minority communities and low-income communities access to public information on matters relating to their health or the environment
- Provide these communities an opportunity to participate in matters relating to their health or the environment

18.2.2. NATIONAL ENVIRONMENTAL POLICY ACT

NEPA and NASA's Environmental Justice Implementation Plans (EJIPs) (described in Section 8.2.3.2) are NASA's primary mechanisms for implementing the Executive Order. When appropriate, environmental assessments and environmental impact statements will be used to evaluate potential environmental effects (including human health, economic, and social) of ARC's activities on minority communities and low-income communities.

18.2.3. NASA SUPPORTING POLICIES AND PROCEDURES

ARC has developed a number of policies and procedures by which to minimize regional impacts from operations and increase stakeholders' involvement in activities. Some of these are:

- Pollution Prevention/Waste Minimization
- Hazardous Materials Management
- Hazardous Waste Management
- Industrial Wastewater Management

- Medical Waste Management
- Environmental Training
- Air Pollution Control
- Polychlorinated Biphenyls Management
- Storage Tank Management
- Hazardous Materials Closure Plans
- Storm Water Management
- Spill Prevention Control and Countermeasures Plan and Facility Response Plan
- Emergency Planning and Community Right-To-Know
- Emergency Response
- Community Relations and Public Participation
- Environmental Justice
- NEPA
- Toxic Gas Management Procedures

18.2.3.1. Public Participation Program

Pursuant to Section 3-302 of Executive Order 12898, subpart (b), NASA must inform the public when programs, policies, or activities regarding environmental justice concerns arise. At a minimum, NASA holds public meetings at times and in places that are convenient to the public to provide information and solicit comments from the community if proposed actions may impact local communities.

18.2.3.2. NASA's Environmental Justice Implementation Plans

In 1995, NASA published an agency-wide Environmental Justice Strategy, pursuant to Section 2-2 of Executive Order 12898. The purpose of this strategy is to ensure the integration of environmental justice into NASA's activities, programs, and policies through the development and implementation of location-specific EJIPs.

ARC (as well as other NASA centers) developed its own EJIP (see Appendix A) and adapted its NEPA process to ensure that environmental justice concerns are addressed in each environmental assessment and environmental impact statement, as appropriate. According to the Executive Order, evaluation of potential environmental justice impacts should be based on socioeconomic information to the extent possible, identifying minority populations and/or low-income populations that may be adversely affected.

18.3. REGIONAL SETTING

Information regarding minority populations and low-income populations was gathered from the 15 census tracts located along Highway 101 within 5 kilometers (3.1 miles) of ARC. These tracts include single- and multi-family homes and mobile home parks within the cities of Mountain View and Sunnyvale, as well as the Berry Court and Orion Park Military Housing areas located outside ARC boundaries, but still within Moffett Field (Figure 18-1). The information presented below is based on data gathered from the 2000 censuses (U.S. Department of Commerce, Bureau of Census 2003, 2004).

18.3.1. MINORITY POPULATIONS

According to 2000 census data, the minority breakdown in Sunnyvale is 32% Asian, 17% Hispanic, and 8% other. Eight census tracts in Sunnyvale are considered minority communities due to the higher-than-average percentage of Hispanic residents: tracts 5046.02, 5048.06, 5048.02, 5052.02, 5089, 5090, 5088, and 5053.01, as shown in Figure 18-1. Four census tracts are minority communities due to the higher-than-average percentage of Asian residents: tracts 5048.02, 5087.03, 5081.01, and 5078.05. Three census tracts contain higher- than-average minority communities designated as other: tracts 5046.02, 5090, and 5084.04, (see Figure 18-1).

Mountain View defines a minority community as an area of the city "with the highest concentrations of minority groups relative to the rest of the City According to 2000 census data, census tract 5091.07 has an Asian population (35.3%) that is higher than the city average (20.3%). Census tract 5094.04 contains a higher percentage of minorities designated as other (19.8%) than the city average (7.5%). Three census tracts, 5093.04, 5094.04, and 5091.08, have Hispanic populations ranging from 26.6%, which is higher than the city average of 16.6%.

18.3.2. LOW-INCOME POPULATIONS

Low-income households, as defined by HUD, are those earning less than 51 to 80% of the mean household income, while very low-income households are those with less than 50% of the mean household income. Based on 1990 census data, the mean incomes in the cities of Mountain View and Sunnyvale are $51,970 and $55,570, respectively. Based on this data, it is assumed that low-income households earn between $25,000 and $39,999 and that very low-income households earn less than $25,000.

Based on 1990 census data, 22.7% of households surrounding ARC are considered very low-income and 21.8% are considered low-income. In Santa Clara County, 21.4% are considered very low-income and 18.3% are considered low-income. The tracts surrounding ARC have a 44.5% combined total of very low- and low-income households, compared to only 39.7% in Santa Clara County. The following are tracts within the census area that have combined percentages of very low- and low-income households higher than the county average: tracts 5046.01 (69%), 5046.98 (61.4%), 5048.03 (51.8%), 5048.04 (52.7%), 5052.01 (62.7%), and 5093 (56%).

Sunnyvale defines a low-income area as that in which the percentage of low-income persons exceeds 40%. Using this definition and 2000 census data, census tracts 5052.05 and 5083.04 would be considered low-income, as shown in Figure 18-1

Mountain View defines a low-income area as that in which more than 37.64% of the residents have incomes that are 80% or less of median income (Mountain View General Plan 2000. Using this definition and 2000 census data, six census tracts are considered low-income: tracts 5046.01, 5093.03, 5093.04, 5094.01, 5094.02, and 5095, as shown in Figure 18-1

18.4. EXISTING SITE CONDITIONS

The Executive Order does not describe precisely how wide an area around a federal facility to consider when identifying and evaluating the environmental effects of a facility's existing or proposed programs and activities. In order to ensure the inclusion of all residential communities in the EJIP, NASA has identified and evaluated the environmental effects of its activities. Environmental impacts from both normal operations and accidental releases at ARC have been assessed (see Appendix A). Few of the normal operations at ARC create offsite impacts to the cities of Mountain View and Sunnyvale; however, these communities are persistently concerned about noise, especially that generated by ARC's wind tunnel tests and Moffett Federal Airfield's aircraft flight operations.

Existing NASA operations were not found to significantly or disproportionately affect surrounding minority or low-income communities. Because aircraft operations have declined over the past few years as federal agency airfield users have left, new resident agency tenants and airfield users are being sought. Therefore, it is anticipated that noise will continue to be a long-term concern, although noise from Ames does not disproportionately impact minority or low-income communities.

Hazardous materials releases were evaluated and measures were implemented to reduce or eliminate the risk and impacts of accidental toxic gas releases. The quantity of toxic gases in storage is limited to volumes that would not generate offsite effects. Furthermore, the use of toxic gases is restricted to properly designed cabinets equipped with continuous monitoring devices, alarms, and abatement equipment.

18.5. ENVIRONMENTAL MEASURES

NASA and ARC have identified the following environmental measures that are designed to address potential environmental justice impacts of operations and future development at ARC and are implemented to the extent feasible.

ARC is committed to avoiding disproportionate impacts to local minority or low-income communities as a result of normal operations, accidental releases, or proposed projects. As discussed above under Section 18.2, Regulatory Requirements, the purpose of ARC's EJIP is to determine whether any of the neighboring minority and low-income populations could be experiencing disproportionately high and adverse environmental effects as the result of ARC's programs, policies, or activities. If disproportionately high and adverse human health and environmental effects on minority communities or low-income communities are identified, the EJIP advocates that prudent measures be developed for eliminating or mitigating these effects, to the extent practicable.

In addition, under its Public Participation Program, ARC develops public documents on environmental issues and publishes public meeting notices in local English language and non-English language newspapers. ARC also places all environmental documents in two local libraries so that they are easily accessible to the public. NASA maintains up-to-date mailing lists of interested stakeholders to whom they send periodic updates to ensure full awareness of ARC's operations and potential impacts.

NASA is also committed to requiring at least 10% of onsite housing to be affordable to low-income households at the time of future development.

18.5.1. MITIGATION MEASURES

The NASA Ames Development Plan (NADP) Final Programmatic Environmental Impact Statement (FEIS) identified mitigation measures to address potential environmental justice impacts from build out of Mitigated Alternative 5 in the NADP (Design, Community & Environment 2002). For a full discussion of impacts and mitigation measures related to the NADP, see the FEIS.

Chapter 19. Sustainability

19.1. OVERVIEW

Sustainable development is the concept of balancing the desire for economic growth with the necessity of environmental protection. The core conflict is between progress and preservation. Sustainable development addresses this conflict by focusing on the interdependency of economic, environmental, social, and cultural systems.

Sustainability is not a regression to primitive living conditions. It involves understanding community and global conditions and developing in ways that minimize irrevocable damage to Earth's ecology while allowing for equitable economic growth.

The term *sustainable development,* as it relates to "green buildings" and/or "environmentally responsible facilities," refers to structures and designs that cause no net environmental burden or deficit. Beginning with the earliest stages of project planning, sustainable development considers a building's total economic and environmental impact, including raw material extraction, product manufacturing, product transportation, building design, construction, operations, maintenance, and building reuse or disposal. Sustainable building practices have been primarily voluntary, but regulations are likely to become more prominent in the building industry.

19.2. BIOSPHERE LIMITS: THE NEED FOR SUSTAINABILITY

The planet has finite quantities of air, water, and land. There are limits to how much can be consumed before natural resources are exhausted. Growth will be constrained by ecological limits. Each system has a finite carrying capacity. Pollution influences the ability of nonhuman life to survive and threatens the quality of human and nonhuman lives.

Examples of long-term ecological damage caused by unsustainable societal practices fall into three broad classes:

- Atmospheric change, including the greenhouse effect, ozone layer depletion, acid rain, and climate change
- Depletion or destruction of renewable resources, deforestation, desertification, water depletion, and species extinction
- Ecotoxicity or pollution of land and water by pesticides, herbicides, toxic substances, and other wastes

19.3. THE HISTORY OF SUSTAINABILITY

The concept of sustainability has a long history. However, term been widely discussed only recently. The modern roots of sustainability began in the early 20th century as a theory of renewable resource management, most notably in sustainable agriculture and forestry, and in theories of sustained yield. The power of sustainability lies in the integration of economic, social, and ecological systems, and the realization that current rates of consumption and pollution cannot continue.

19.4. THE FUTURE OF SUSTAINABILITY

Sustainability will continue to be of interest to environmental professionals and to the global community into the next millennium. The increasing human population growth, resource consumption, and pollution production of modern development are not ecologically sustainable. Clear direction and guidance are needed to achieve increasingly sustainable development. Therefore, multidisciplinary experts must agree on (1) the best approaches to timely achievement of sustainability and (2) implementation of such agreements.

Increasing awareness of sustainability helps define current problems. One of ARC's objectives is to motivate the people at ARC to develop green lifestyles based on a full understanding of the individual's impacts on the environment.

19.5. APPLICABILITY TO ARC

ARC complies with environmental laws and regulations pertaining to sustainable development. The following regulatory drivers are applicable:

19.5.1. FEDERAL LAWS

- 42 U.S.C. 6901, Resource Conservation and Recovery Act
- 42 U.S.C. 8251 et. seq., Federal Energy Management
- 42 U.S.C. 13101–13109, Pollution Prevention Act of 1990
- Executive Order 13101, "Greening the Government Through Waste Prevention, Recycling and Federal Acquisition"
- Executive Order 13123, "Greening the Government Through Efficient Energy Management"
- Executive Order 13148, "Greening the Government Through Leadership in Environmental Management"

- Executive Order 13150, “Federal Workforce Transportation”
- Presidential Memorandum on Environmentally and Economically Beneficial Landscape Practices on Federal Landscaped Grounds
- 40 CFR Part 247, Comprehensive Procurement Guidelines
- 10 CFR Part 435, Energy Conservation Voluntary Performance Standards for New Buildings; Mandatory for Federal Buildings
- U. S. Energy Policy Act of 1992

19.5.2. STATE LAWS

- California Code of Regulations Title 13, Air Resources Board
- California Code of Regulations Title 22, Environmental Health
- California Code of Regulations Title 23, Waters
- California Code of Regulations Title 24 Part 6, California's Energy Efficiency Standards for Residential and Nonresidential Buildings
- California Health and Safety Code

19.5.3. NASA

- NASA Strategy Document, Environmental Excellence for the 21st Century
- NPD 8500.1, “NASA Environmental Management”
- APD 8800.4, “Ames Environmental Programs”
- APR 8800.3, “Ames Environmental Procedural Requirements”

19.6. DEFINITIONS

Environmentally Preferable means products or services with limited or no impact on human health and the environment as compared with other products and services that serve the same purpose. The comparison will consider the entire lifecycle of a product, including acquisition of raw materials, manufacture, use, reuse, recycling, and disposal.

Lifecycle of a product includes procurement of the original raw materials, processing, manufacturing, transportation, use, reuse, and recycling or disposal. It is also defined as the consecutive and interlinked stages of a product system, from raw material acquisition or generation of natural resources to the final disposal.

Lifecycle Assessment is the systematic compilation and evaluation of the inputs, outputs, and potential environmental impacts of a product throughout its lifecycle.

Lifecycle Impact Assessment is that phase of lifecycle assessment aimed at understanding and evaluating the magnitude and significance of the potential environmental impacts of a product system.

Renewable Resource is a resource, such as energy, water, or a raw material, which is consumed at a rate that does not exceed its ability to naturally replenish or regenerate itself.

19.7. MANAGING SUSTAINABILITY

Several tools are available to help achieve sustainable development. They help to assess the situation, manage impacts, and monitor progress. Some tools are listed below. The Environmental Office can provide additional information on these programs.

- The Eco Management and Audit Scheme (EMAS) and ISO14001
- The Sustainability Checklist
- Sustainable Development Indicators
- Strategic Environmental Assessment
- Sustainability and State of the Environment Reporting
- Environmental Impact Assessment

19.8. FACILITIES

To promote sustainable development, there is a body of practical advice on how to plan, design, construct, operate, and maintain buildings to balance facility lifecycle cost, environmental impact, and occupant health, safety, security, and productivity.

The essential elements of sustainability include:

- Energy and resource efficiency, including water conservation
- Site selection to minimize impacts to the environment (e.g., through transportation)
- Optimize energy, environmental, and lifecycle costs associated with construction, operation, and decommissioning of facilities
- Use of sustainable materials (that is, reused, recycled, recyclable, nontoxic, low-embodied energy content, renewable, long lifecycle, resource efficient, harvested on a sustained yield basis, and least polluting)
- Emphasis on durability and efficiency of materials and equipment

- A healthy environment, including indoor air quality
- Features in support of enhanced worker productivity
- Design for personnel safety and security
- Design for decommissioning and disposal
- A philosophy that defines facility operational objectives, then tests and verifies that all building systems and components have been properly installed and perform to the level intended (that is, Building Commissioning)

19.8.1. USE LEED

The LEED (Leadership in Energy and Environmental Design) Green Building Rating System® developed by the U.S. Green Building Council, evaluates a building's environmental performance over its lifecycle and assigns credits to projects for satisfying a list of criteria. The system provides a definitive standard for what constitutes a "green building" by awarding different levels of green building certification based on the total credits earned. Development at ARC should strive for the highest possible LEED rating in building design, and must meet at least the minimum required score to achieve LEED silver certification.

19.9. EFFICIENT RESOURCE USE AND ENVIRONMENTAL PURCHASING

Elements that promote efficient resource use and environmental purchasing include:

- Encourage purchasing of products that create less waste
- Choose products that are durable, repairable, and recyclable
- Avoid over packaging
- Encourage purchase of goods made from recycled materials
- Discourage purchase of environmentally damaging or polluting materials, such as tropical hardwood, peat, formaldehyde-based laminates, PVC, or ozone-depleting substances
- Support and promote projects and enterprises for the repair and reuse of furniture, clothes, and other goods
- Encourage people to use hiring/lending services, such as libraries, tool hire, and car hire, in *preference to buying new goods*

- Address the impact of the building industry on resource use and waste by specifying reused materials in construction contracts and planning policies, and encouraging adaptable and durable building designs

19.10. DESIGN FOR THE ENVIRONMENT

Products designed for the protection of the environment are available. Such products are made from renewable resources harvested in a sustainable manner, fabricated with recyclability goals, and produced using energy efficiently. Make purchases that favor sustainability. Buy items that are designed for the environment.

19.11. STAGES OF SUSTAINABLE DEVELOPMENT PROJECTS

Sustainable construction projects progress through stages during their lifecycle. However, sustainable development projects differ from typical construction projects because a multidisciplinary design and construction team is formed early in the process. This team cooperatively plans and integrates the project's functional and operational requirements into the achievement of specific environmental and economic goals. Members of the team could include planners, architects, engineers, construction quality assurance specialists, contractors, building occupants, and environmental and energy managers. An outline of the principal stages and essential concerns for each stage follows.

19.11.1. PLANNING

Project concepts, goals, sustainability, and budgets are established. This is where the project team should begin considering and incorporating sustainable development practices. Federal acquisition regulations require contractor selection criteria to include specialized experience and technical competence in the type of work required, including, where appropriate, experience in energy conservation, pollution prevention, waste reduction, and the use of recycled materials.

19.11.2. REQUIREMENTS ANALYSIS

Information is gathered in preparation for design. The project team should review operations and maintenance requirements. Review of environmental impact studies, pollution prevention plans, energy use, budgets, and site surveys create a foundation that helps ensure an optimal design for human and natural environments.

19.11.3. PROJECT DEFINITION

For most projects, a conceptual design is created during a collaborative, multidisciplinary work session during which the project design, plan, and major systems are defined. Since these decisions set the direction for the design, they largely determine the team's ultimate success in meeting the project's design-for-environment goals.

19.11.4. CONTRACT DOCUMENT DEVELOPMENT

Construction plans and specifications are developed at this stage. Useful tools at this stage are checklists of sustainable development actions related to site work, water quality and conservation, energy efficiency, building material selection, and waste management.

19.11.5. CONSTRUCTION

Installation practices that maintain good air quality, water quality, conservation of natural resources, and waste reduction are high priorities during construction of sustainable facilities. Contractors should be educated about these priorities and their role in achieving them. Quality assurance evaluators play an essential role in ensuring that sustainable design provisions in contract documents are translated into finished projects.

19.11.6. OCCUPANCY, OPERATIONS AND MAINTENANCE

A sustainable facility cannot fulfill its environmental and economic potential without the cooperation of knowledgeable occupants and maintainers. If personnel are educated about sustainability and have been involved throughout the process, the transition will be increasingly smooth and the project team's sustainability goals closer to realization.

19.11.7. POST-OCCUPANCY EVALUATION

Facility managers, in cooperation with environmental engineers can perform evaluations to measure the facility's water and energy consumption, indoor air quality, and waste generation. Maintenance requirements and operational costs should also be considered. This performance data measures the sustainability of construction and establishes a benchmark for future projects.

19.11.8. FACILITY REUSE

Evaluate existing facilities thoroughly before deciding whether to reuse or demolish.

19.12. EDUCATION AND TRAINING

Sustainability-focused education and training work toward developing high levels of awareness of sustainability among ARC employees to provide a workforce well prepared for delivering quality, environmentally sustainable services and products.

19.13. WALK, BIKE, OR TAKE PUBLIC TRANSPORTATION

The Ames Commute Alternative Program (ACAP) assists civil servants, contractors, and visitors in choosing transportation other than single-occupant vehicles. General acceptance of transportation alternatives to the single-occupant vehicle would reduce air, soil, water pollution, traffic congestion, and vehicle accident deaths. Through ACAP, ARC has information on car and vanpool, mass transit, and telecommuting. Past and current ACAP activities include:

- In 1996, ARC employees participated in and won the North Bayshore Bike-to-Work Challenge. Bike-to-Work is a community-wide celebration and public education effort that provides incentives for people to commute by bicycle. Biking is an inexpensive, healthy, and fun way to alleviate gridlock and reduce air pollution.
- The NASA shuttle service is provided by ACAP in compliance with the Bay Area Air Quality Management District's former Trip Reduction Law-Regulation 13. This law required employers to provide commute incentives to reduce traffic congestion and air pollution. The shuttle transports commuters to and from the Mountain View Caltrain Station and the Valley Transit Authority light rail in the morning and afternoon. Shuttle service is available to ARC civil service and contractor employees only. All shuttles are wheelchair accessible and have bicycle accommodations. A NASA badge is required to board the bus.
- "Spare the Air Tonight" starts in mid-November and extends through the end of January. This program targets the reduction of carbon monoxide and particulate matter that can reach unhealthy concentrations on cold nights with little air movement. Every winter, the Bay Area Air Quality Management District asks Bay Area residents to cooperate to improve air quality on days when pollution threatens to reach unhealthy levels. When a Spare-the-Air-Tonight advisory is issued, residents are requested to avoid driving and refrain from lighting fireplaces and woodstoves (unless the stove or fireplace, containing an insert, is a clean-burning EPA-certified model).
- The Bay Area Air Quality Management District donates Santa Clara County bus or CalTrain tickets to anyone not already using public transportation. The tickets are good for any day announced as a spare-the-air day. This provides an opportunity for people unfamiliar with public transit to experience the benefits of stress-free commuting.

19.14. REFUSE, REDUCE, REUSE, AND RECYCLE

ARC's Environmental Office is responsible for selecting offsite management of the center's hazardous waste. This selection is based on the recycling, reuse, treatment, and disposal hierarchy. During 1998, the Environmental Office diverted 578,645 pounds of the total generated quantity of 927,943 pounds from landfills by recycling. This included used oil, oily water, batteries, florescent light tubes, and empty containers.

ARC also recycles white paper, mixed paper, cardboard, and plastic, glass, and aluminum containers.

Surplus equipment, including vehicles, computers, furniture, communication equipment, construction equipment, lab equipment, and other items, are managed at ARC by returning them to a central location, the warehouse/storestock. Center personnel can select needed equipment from the stock for a period of about one month. Equipment not claimed after this period is donated to area schools. Following selection by the schools, the surplus equipment is available for purchase. Items are sent to the General Services Administration to auction online. The administration's online auction is at http://www.gsaauctions.gov. Use of these alternatives is encouraged.

19.15. DISPOSE OF TOXIC WASTE RESPONSIBLY

The Environmental Office is responsible for conducting a comprehensive environmental audit of ARC operations. A stated preference of hazardous waste management at ARC is source reduction, reuse, recycling, treatment, and disposal in permitted and secure landfills, in that order. Disposal by underground well injection is not allowed.

The Environmental Office operates the Ames Chemical Exchange (ACE) program, which diverts hazardous substances from disposal as hazardous waste. Specific guidelines on waste management are provided through an ongoing generator-assistance program. More information on hazardous materials and pollution prevention is found in *Chapter 17, Hazardous Materials*.

19.16. TURNING OFF COMPUTER AND LIGHTS WHEN LEAVING A ROOM

To be energy efficient, individual civil servant and contractor personnel are encouraged to practice energy conservation throughout ARC facilities. The use of energy efficient lighting and appliances is highly recommended and generally implemented. Turning off equipment and lights when going home saves energy and reduces costs. Further discussion on energy is in *Chapter 15, Public Services, Utilities, and Energy*.

19.17. COMPOSTING BIODEGRADABLE WASTE

ARC recycles all landscaping green waste, as discussed in *Chapter 17, Hazardous Materials*. This waste includes grass clippings, leaves, and tree branches. Tree branches are shredded before composting.

19.18. DECREASE USE OF WATER

Individual employees at ARC reduce water consumption and costs by using less water throughout the center. ARC spends more than $100,000 per year to import fresh water and to dispose of the wastewater. Unnecessary use of potable water is wasteful. To conserve water:

- Do not leave the taps running (unless flushing pipes at the request of the Environment Office
- Work in partnership with water suppliers to encourage other civil servants and contractors to make the most efficient use of water and become increasingly aware of the impact of water use
- Install increasingly efficient appliances/processes

19.19. DECREASE USE OF PAPER

ARC has copy machines capable of two-sided copying. ARC also purchases paper with a 100 percent post-consumer recycled content. Employees are encouraged to make double-sided photocopies and to always use two sides of paper before disposing of paper in recycling bins. ARC also encourages the use of email and electronic files instead of creating excess paper copies and paper file systems.

19.20. OTHER TIPS FOR REDUCING ENVIRONMENTAL IMPACT

Use of coffee mugs instead of Styrofoam or other disposable cups is encouraged. Make sure the vehicles are tuned up, and avoid any leaks or adverse emissions from vehicles.

19.21. SUSTAINABILITY AT ARC

Accepting the concept that sustainability is the integration of ecological, economic, and cultural concerns, individual and community activities should be conducted in a sustainable manner. It is ARC policy to:

- Have sustainability indicators provide evidence that ARC activities are conducted according to desired goals. To be effective, indicators must evaluate both objective and subjective information. The process of creating and using indicators is a useful planning tool for measuring quality of life
- Plan for sustainability using objective and subjective information, including hard data and perception of trends
- Minimize its environmental impacts on the neighboring community and create a healthy environment for workers, visitors, and neighbors
- Communicate and disseminate the concepts in this and other chapters of this document to ARC employees
- Use resources efficiently and minimize the consumption of raw material resources (energy, water, land, and materials) from construction to the end of facilities' useful lives. Maximize the reuse of resources
- Seek renewable energy sources as opposed to using fossil fuels. Design facilities for long-term durability, flexibility, and eventual reuse. Protect and restore the natural environment
- Move beyond traditional quality criteria involving schedules and budgets and move toward sustainability by including conservation of resources, promotion of a healthy workplace, and avoidance of environmental degradation
- Rent equipment that is only used occasionally. Purchase remanufactured office equipment
- Purchase concentrates and products with minimal packaging. Reclaim reusable parts from old equipment
- Send meeting minutes via email or post minutes on a server
- Provide recycling bins. Post waste reduction signs to remind personnel to recycle. Buy recyclable paper byproducts whenever possible. Use recycling bins.

19.22. PROMOTING SUSTAINABILITY

The Union of Concerned Scientists (www.ucsusa.org) has simplified advice on what should and can be done to promote sustainability on Earth. The Union of Concerned Scientists advises individuals to take the following steps to reducing the impact their activities have on the environment.

- Use less energy in the home
- Insulate. Turn heat down when not at home

- Buy green power (wind, biomass, geothermal, solar, or hydroelectric). Minimize use of coal, oil, and nuclear power
- Buy organic foods and products
- Use less energy in transportation
- Walk. Bike. Take public transportation. Buy smaller energy-efficient vehicles. Buy electric vehicles. Carpool. Maintain vehicles to reduce emissions

Decreasing the amount of energy or resources consumed decreases the amount of pollution produced.

Chapter 20. Institutional Controls

20.1. OVERVIEW

Institutional controls (IC's) are actions, such as legal controls, that help minimize the potential for human exposure to contamination by ensuring appropriate land or resource use.

Although it is expected that treatment or engineering controls will be used to address principle threat wastes and that groundwater will be returned to its beneficial use whenever practicable, ICs can and do play an important role in remedies.

ICs are used when contamination is first discovered, when remedies are ongoing and when residual contamination remains onsite at a level that does not allow for unrestricted use and unlimited exposure after cleanup. The National Contingency Plan (NCP) emphasizes that ICs are meant to supplement engineering controls and that ICs will rarely be the sole remedy at a site.

20.2. REGULATORY REQUIREMENTS

Section 120(h)(3)(A) of CERCLA requires that a federal agency transferring real property to a nonfederal entity include a covenant in the deed of transfer warranting that all remedial action necessary to protect human health and the environment has been taken prior to the date of transfer with respect to any hazardous substances remaining on the property. (By "transferring federal agency," EPA means the federal agency responsible for cleanup.) In addition, CERCLA section 120(h)(3)(B) requires, under certain circumstances, that a federal agency demonstrate to the EPA Administrator that a remedy is "operating properly and successfully" before the federal agency can provide the "all remedial action has been taken" covenant. Under CERCLA section 120(h)(3)(C), the covenant can be deferred so that property may be transferred before all necessary remedial actions have been taken if regulators agree that the property is suitable for the intended use and the intended use is consistent with protection of human health and the environment.

In August 1996, EPA issued guidance to EPA's Regional Federal Facility programs describing the approach EPA should use in evaluating a federal agency's demonstration that a remedial action is "operating properly and successfully" as a precondition to the deed transfer of federally-owned property, as required in CERCLA section 120(h)(3)(B).

In that guidance, entitled Guidance for Evaluation of Federal Agency Demonstrations that Remedial Actions are Operating Properly and Successfully under CERCLA Section 120(h)(3), EPA directed Regional decision-makers to consider a number of factors in evaluating an "operating properly and successfully demonstration" of ongoing remedial actions, including institutional controls. With respect to institutional controls, EPA stated generally that, "If the integrity of the remedial action depends on institutional controls (for example, deed restrictions, well drilling prohibitions) these controls should be clearly identified and agreed upon."

Additionally, under the more specific criteria that must be demonstrated for groundwater remedies, the 1996 guidance included "appropriate institutional controls are in place" as a criterion, but did not describe how federal agencies should meet this requirement.

Successful management of institutional controls is critical to protecting the human health and environment of the communities where federal properties are located. For this reason, early communication and cooperation among federal, state, local, and tribal governments in the development of institutional controls and implementation plans is encouraged.

Where the viability of the institutional control is contingent on state property law or where state institutional control-related laws may apply (e.g., documentation of institutional controls in a state registry), it is particularly important to coordinate with the state. As a matter of policy, therefore, EPA will forward all institutional control information received for federal property transfers to the appropriate state, local, and tribal governments. EPA also will solicit comments from these organizations as appropriate.

EPA prefers to work with federal agencies early in the remedy selection process to assure full and consistent consideration of the long-term effectiveness of the institutional controls. For this reason, it is imperative that these discussions begin prior to remedy selection. Although the federal government has had less experience designing and implementing institutional controls than engineered remedies, EPA will use its professional judgment in evaluating institutional control plans, as it does in evaluating other aspects of remedies and operations and maintenance. The basis for that judgment may vary depending on the site characteristics. EPA understands the importance of rapid reuse to the surrounding communities and is committed to supporting this effort while maintaining the Agency's primary goal of protecting human health and the environment.

20.3. **REGIONAL SETTING**

ARC's core businesses are astrobiology, nanotechnology, information technology, aviation systems, airspace operations, research and development, and related support operations. Resident agencies conduct a variety of activities, including research and development, airfield operations, administrative, and military support operations. As such, routine operations require the use of numerous types and quantities of hazardous materials, resulting in the generation of hazardous and nonhazardous wastes at ARC.

At any given time, there may be more than 5,000 hazardous substances in the laboratories, shops, and other facilities within the Ames Campus area, producing a comparable number of types of hazardous waste. The quantities from laboratories are often small: ounces or grams of particular substances; quantities from shops and other operations may be greater than 55 gallons.

20.3.1. REGIONAL PLUME

A plume of contaminated groundwater flows northward beneath ARC toward the San Francisco Bay. At present, the plume underlies a total of 130 hectares (320 acres) of ARC, most of which is within the NRP area. The main contaminants in the plume are volatile organic compounds (VOCs), among them trichloroethene, 1,1,1-trichloroethane, cis- and trans- 1,2 dichloroethene, 1,1-dichloroethane, 1,1-dichloroethene, dichlorobenzene, chloroform, Freon 113, phenol, and vinyl chloride. The first two are the most commonly found (Harding Lawson Associates 2000, in Design, Community & Environment 2002).

The Regional Plume stems from two main sources: an EPA-designated Superfund site outside of ARC at the Middlefield-Ellis-Whisman (MEW) site across U.S. Highway 101, and contamination from the operation of a dry cleaning facility, a former aircraft wash rack and sump, a fueling station, and numerous underground storage tanks at Moffett Field during the Navy's administration of the base.

20.4. MEMORANDUM OF UNDERSTANDING (MOU) NASA NAVY 1992:

Navy retains responsibility for all environmental restoration or remediation requirements arising from its activities including compliance with Federal Facilities Agreement (FFA) of 1989. NASA is not a party to the FFA. Navy is responsible for any contamination existing on the former Naval Air Station Moffett Field (NASMF), or migrating from the NASMF, even if not required by the FFA, and even if the contamination migrated onto NASMF from another site. NASA is responsible for any contamination resulting from its activities.

20.5. MOU NAVY TO NASA 1993:

Navy will take possession of, and properly manage, any contaminated soil or groundwater that was left in place in accordance with a CERCLA, RCRA, or other cleanup remedy.

NASA will sample prior to excavation or other disturbance. NASA shall minimize construction in contaminated areas, and shall notify the Navy prior to any construction on adjacent to contaminated areas.

Navy retains responsibility for all environmental requirements related to its activities including:

- Repair or replacement of leaking PCB transformers, and remediation of leaks
- Removal or closure of underground storage tanks and remediation of contamination
- IDS of all asbestos, remediation of any friable asbestos
- Remediation of soil contamination from lead paint
- Remediation of contamination in sanitary sewer storm drains
- Remediation of releases at hazardous waste packaging areas
- Remediation of contaminants resulting from delivery and storage of fuel, and operations of aircraft fuel systems

Navy provides all required support until remediation is complete including maintenance of containment, treatment and monitoring systems, and post closure monitoring. If NASA is fined because Navy delays implementation of the FFA, Navy will address the penalty. NASA assumes no liability for activities related to Navy's remediation program. Although NASA will assume operation of NASMF, Navy will remain responsible for environmental remediation and restoration. Navy shall provide USEPA and Cal EPA 30 days notice

20.6. NASA NAVY MOU 1999:

NASA will not take any actions that would compromise the landfill cap at site 1.

NASA will maintain the Building 191 pump station and drain/sub drain system under the airfield runways.

Site 5 is the main fuel facility for Moffett Field. The fuel farm site is divided into two parts: Site 5 north and south. Originally, the fuel farm consisted of 10 underground bulk storage tanks and four aboveground storage tanks. Six of the underground tanks were removed in 1995 from Site 5 south. The remaining eight tanks, four underground and four aboveground, are located in Site 5 north. These tanks are going through a closure process by the Defense Energy Supply Center (DESC). There is soil and groundwater contamination at both locations, with the heaviest contamination in Site 5 north. The Navy is currently studying the site as part of its petroleum sites evaluation and closure program to determine what remediation will be needed. There is no remediation effort currently underway at Site 5.

Access to this area is restricted to authorized personnel.

20.7. AGREEMENTS WITH NEW RESIDENTS

Prepare new, or revise existing procedures to include new property. For example:

- Inform maintenance and construction workers of locations of soil and groundwater contamination
- Develop procedure for sampling and proper disposition
- Provide required training and personal protective equipment
- Develop procedures to protect historic buildings
- Revise internal environmental compliance audit protocols to include new residents
- Complete NEPA documentation
- Obtain NASA concurrence prior to project implementation
- Provide secondary containment for hazardous materials storage permits from Santa Clara County
- Obtain any authority to construct and permits to operate any air pollution sources from BAAQMD and give copies to NASA.

NASA Agreements with Resident Partners state that the Resident Partner is responsible for:

- Compliance with all environmental laws, rules, regulations and ordinances
- Paying of all fines and penalties assessed by any Federal, State, or local environmental agency
- Restoration or remediation of any release of any pollutant or contaminant,
- Providing access to the Navy for Navy remedial activities
- Any damage to Navy environmental restoration activities
- Consulting and cooperating with NASA on environmental matters
- Providing information to NASA for inclusion in its Spill Prevention Control and Countermeasures Plan, Storm Water Pollution Prevention Plan, Hazardous Waste Minimization Plan, and any other site wide environmental plans

- Managing hazardous waste in compliance with federal, state, and local requirements
- Reimbursing NASA's cost to characterize, collect, package, and transport the hazardous waste to a permitted facility
- Allow NASA access to conduct environmental compliance audits, to test for environmental hazards, or to conduct remediation operations
- Notifying NASA of emergency conditions that affect safety or environmental health